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Bulletin on NARCOTICS

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GENERAL

Drug Addiction:

Medical and Social Aspects in France

By C. Vaille and G. Stern

Mr. Charles Vaille, Chief of the Service Central de la Pharmacie of the Public Health and Population Ministry of France, is the delegate of France to the Commission on Narcotic Drugs; he is now the President of the Commission. Mr. G. Stern, the co-author of the article, is Chief of the Bureau of Narcotics of the above-mentioned Ministry.

Introduction

In those regions of the globe where opium, cannabis or coca leaf are consumed on a large scale, drug addiction is rightly considered as a social scourge.

The practical problems raised by the consumption of narcotic drugs in Western countries are of a different kind. The number of persons who take narcotic drugs for non-therapeutic purposes is smaller; the principal narcotics used are the so-called white drugs (morphine, heroin, etc.) and the origin of their use is different. The Western peoples acquired their knowledge of narcotic drugs in the nineteenth century, through the medium of therapeutics. The illicit use of such drugs was rapidly checked by the enactment of very strict regulations.

In spite of the admittedly social nature of drug addiction, the amount of sociological information available on the subject is small. The numerous publications which have dealt with the question are not lacking in qualitative elements, but most of them are devoid of quantitative data.

I. Statistical data in France

A. *Data for the country as a whole, 1946 to 1949*

The authors have made a systematic study of the cases of addiction observed during the years 1946, 1947, 1948 and the first nine months of 1949.

During this period, 687 cases were investigated.

On the basis of this initial fact it may be stated that at present drug addiction in France in no way constitutes a social scourge. If we raise the above figure to 1,000, it would represent .002 per cent, for 42 million inhabitants, i.e., two addicts for every 100,000 inhabitants.

For the purposes of this inquiry, addicts were classified by sex, age, origin of addiction, substances employed and means of absorption and occupation.

1. *Sex:* Of 687 cases 328 were men, i.e., 47 per cent, and 359 women, i.e., 53 per cent.

This small percentage difference provides no evidence that one sex is more liable to addiction than the other.

It may be noted that the above cases included 50 addicted couples; in other words, 14.5 per cent of the addicts are married to an addict.

2. *Age:* The age of the addicts was ascertained only in 426 cases. The breakdown is as follows:

	Number	*Per cent*
Less than 20 years of age	1	0.2
20 to 24 years of age	15	3.5
25 to 29 years of age	47	11
30 to 34 years of age	55	12.9
35 to 39 years of age	80	18.7
40 to 44 years of age	67	15.7
45 to 49 years of age	66	15.4
50 to 54 years of age	39	9.1
55 to 59 years of age	23	5.3
60 to 64 years of age	17	3.9
65 to 69 years of age	11	2.6
70 to 79 years of age	5	1.1
80 and over	0	
	426	99.4

These figures do not offer a true picture of the distribution of addicts among the various age groups, for the population, of course, is unequally divided, forming what is known as an age pyramid.

In order to deduce the actual relative numbers of addicts, a correction must therefore be applied.

The authors felt that the easiest way would be to proceed by a simple rule-of-three method and calculate what the distribution of addicts would be if all the age

groups comprised the same number of persons, and then to compare the percentages in relationship to the whole.[1]

Figure 1

We thus obtain:

	Per cent
Less than 20 years of age	negligible
20 to 24 years of age	2.7
25 to 29 years of age	11.6
30 to 34 years of age	12.6
35 to 39 years of age	16.4
40 to 44 years of age	13.6
45 to 49 years of age	14.8
50 to 54 years of age	10.4
55 to 59 years of age	6.6
60 to 64 years of age	5.4
65 to 69 years of age	4
70 to 75 years of age	1.5
80 and over	0
	99.6

These figures do not offer exact data concerning the optimum age at which addiction is developed, since they are based on the age of addicts at the time of their detection.

[1] For example: at the 1946 census there were 3,362,000 persons between twenty and twenty-four years of age; 3,054,000 between 35 and 39 years and 1,710,000 between 65 and 69 years. By reducing all these age-groups to 10,000,000, we obtain:

20 to 24 years..... $\frac{15 \times 10{,}000}{3{,}362} = 44$ or 2.7 per cent

35 to 39 years..... $\frac{80 \times 10{,}000}{3{,}054} = 262$ or 16.4 per cent

65 to 69 years..... $\frac{11 \times 10{,}000}{1{,}710} = 64$ or 4 per cent

Whereas, the uncorrected absolute figures were:

20 to 24 years	15 (or 3.5 per cent)
35 to 39 years	80 (or 18.7 per cent)
65 to 69 years	11 (or 2.6 per cent)

The differences are not negligible.

Two peak figures may be noted, one at thirty-five to thirty-nine years and the other at forty-five to forty-nine years. We shall see later that these two peaks correspond to different curves for men and women.

The rapid rise in the figures shows that young people in the strict sense of the term (below twenty-five years of age) are not really affected. The drop after the peak at the forties, although less rapid, is nevertheless appreciable. It suggests obviously that mortality among addicts must be very high as compared with general mortality. This view is supported by the fact that many addicts suffer from some serious disease.

The distribution by sex was established. (The ratio to the distribution of age-groups by sex was considered of no value, since the numerical differences as between men and women are very small, becoming fairly appreciable only after the age of sixty. The figures given here are therefore absolute; the comparison is by percentages.)

Age	Men		Women	
	Number	(Per cent)	Number	(Per cent)
Less than 20 years of age...	0		1	(0.4)
20 to 24 years of age.....	7	(3.7)	8	(3.3)
25 to 29 years of age.....	17	(9)	30	(12.5)
30 to 34 years of age.....	23	(12.2)	32	(13.3)
35 to 39 years of age.....	26	(13.9)	54	(22.5)
40 to 44 years of age.....	33	(17.6)	34	(14.2)
45 to 49 years of age.....	38	(20.3)	28	(11.7)
50 to 54 years of age.....	21	(11.2)	18	(7.5)
55 to 59 years of age.....	7	(3.7)	16	(6.6)
60 to 64 years of age.....	7	(3.7)	10	(4.1)
65 to 69 years of age.....	7	(3.7)	4	(1.6)
70 to 79 years of age.....	1	(0.5)	4	(1.6)
80 and over	0			
	187	(99.5)	239	(99.3)

The comparison between men and women (see attached graph) reveals two curves of fairly similar general trend. There is also a marked difference: the peak for women is between 35 and 39 years and for men between 45 and 49 years.

B. *Data for the Department of the Seine, 1945 to 1952*

It was considered that after the general and rapid study of the data for France as a whole, a more detailed study of the Department of the Seine,[2] i.e., the urban area composed of Paris and its inner suburbs, would be of great significance, for the following reasons:

(*a*) In Western countries drug addiction is mainly found in the large urban centres. The Paris addicts studied here make up 57 per cent of the total number of cases detected in France as a whole since 1945.

(*b*) With the exception of the peasant class, which in any event has been scarcely touched by drug addiction, all the social classes are represented.

(*c*) Whereas in the provinces addiction is almost exclusively of therapeutic origin, in Paris there is a secret drug market. This has no equivalent in the provinces, where proselytism is a factor of less importance.

[2] Population in 1946, 4,775,711.

The addicts covered by the statistics were detected either by the Pharmaceutical Inspectorate or by the police.

While it is impossible to assess accurately the ratio of the number of cases of addiction which have been studied to the number actually in existence, it may be estimated to be fairly large, so that the statistics given below give a true picture of addiction in the Paris area.

(a) *Number of addicts detected since 1945*

The number amounted to 768, including 412 women, i.e., 53.6 per cent, and 356 men, i.e., 46.3 per cent.

The numbers of men and women are roughly the same. There appears therefore to be no evidence that one sex is more disposed to drug addiction than the other.

(b) *Therapeutic origin of addiction*

A study of the case histories has revealed the following facts:

There were 224 cases of therapeutic origin, 380 cases of non-therapeutic origin and 164 cases of undetermined origin.

In other words, for the known cases, 37 per cent were of therapeutic origin, and 63 per cent were of non-therapeutic origin.

By addiction of therapeutic origin we mean addiction contracted in connexion with treatment prescribed by a medical practitioner, such treatment being the patient's first contact with the drug.

Addiction of non-therapeutic origin is addiction contracted as a result of proselytism for reasons not strictly medical, such as personal distress or disappointments, etc.

(c) *Sources of supply*

Addicts procure narcotic drugs from two sources of supply:

a. From the legal market, by licit or illicit methods (regular prescriptions, falsified prescriptions, forged prescriptions, simultaneous consultation of several doctors, wrong prescriptions);

b. From the illicit market.

Out of 768 cases, 344 procure supplies from the legal market, 329 procure supplies from the illicit market, 91 procure supplies from both concurrently and 4 cases are undetermined.

It must be borne in mind that statistics relating to supply from the illicit market are harder to obtain than statistics of supplies from the legal market.

(d) *Recidivism*

During the 8 years covered by the study, 236 addicts (i.e., 30 per cent) relapsed into drug addiction, often several times.

(e) *Addicts engaging in drug traffic*

Certain addicts become drug traffickers. Incapable of meeting their needs, they try to use traffic in drugs as a means of indulging their own vice.

Such addicts are particularly dangerous because they try to attract new addicts in order to increase their clientele. There are 105 such cases, i.e., 14 per cent, among the total number under review.

(f) *Drug addict couples*

Such couples are frequently found; this study covers 61. In other words, 16 per cent of addicts are married to other addicts. The most common reason for the spread of addiction from husband to wife appears to be that narcotic drugs generally cause sexual impotence in men.

The 768 addicts studied were all of Western origin. In order to give a more accurate picture of drug addiction in Paris we should add:

Thirty-nine North Africans who smoke cannabis,

Twenty-four Chinese who smoke opium.

However, while it may be stated that the 768 cases referred to represent a large proportion of the actual number of addicts, it may also be asserted that there are many more users of opium and *kif*[3] among the Chinese and North African Colony. That, moreover, is confirmed by the 1953 statistics for France and the Department of the Seine.[4]

Figure 2

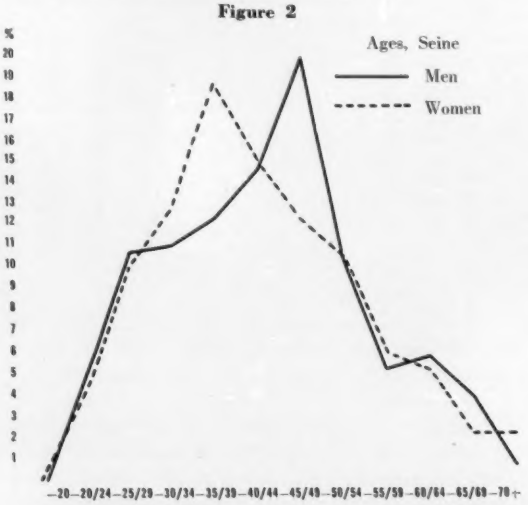


Figure 2 and table no. 1 show the distribution of addicts by various age-groups during a period of eight years. The curves resemble very closely those in figure 1.

[3] Generic name given by North Africans to preparations of cannabis.

[4] These statistics reveal nothing new but for this fact, and confirm the conclusions of this study. In 1953 the number of addicts detected in France amounted to 129, to which must be added 22 North Africans smoking *kif* and 9 Chinese smoking opium. Of the 129 addicts, 82, including 32 in Paris, were discovered for the first time, and 47, including 22 in Paris, were recidivists.

Variation between men and women

The most obvious features are:

Coincidence of the curves before the age of 30 and after the age of 55,

Difference of 10 years between the peaks of the two curves,

Absence of juvenile addiction.

Table No. 1

DISTRIBUTION AND ORIGIN OF ADDICTION IN THE DEPARTMENT OF THE SEINE

(A) Women

Age-group	*Number*	*Per cent*	*Origin of addiction*		
			T[a]	*N.T.*[b]	[c]
Below 20 years of age	2	0.5	0	2	0
20 to 24 years of age	18	4.5	2	13	3
25 to 29 years of age	40	10	9	22	9
30 to 34 years of age	51	12.7	10	27	14
35 to 39 years of age	74	18.5	16	43	15
40 to 44 years of age	61	15	24	27	10
45 to 49 years of age	49	12.2	18	20	11
50 to 54 years of age	42	10.5	15	17	10
55 to 59 years of age	24	6	11	8	5
60 to 64 years of age	21	5.2	8	8	5
65 to 69 years of age	9	2.2	5	1	3
70 and over	9	2.2	2	1	6

(B) Men

Age-group	*Number*	*Per cent*	*Origin of addiction*		
			T[a]	*N.T.*[b]	[c]
Below 20 years of age	0	0			
20 to 24 years of age	18	5.2	2	16	0
25 to 29 years of age	37	10.7	4	32	1
30 to 34 years of age	38	11	7	25	6
35 to 39 years of age	42	12.2	10	22	10
40 to 44 years of age	50	14.5	13	26	11
45 to 49 years of age	68	19.7	22	38	8
50 to 54 years of age	36	10.4	18	11	7
55 to 59 years of age	18	5.2	9	7	2
60 to 64 years of age	20	5.8	10	6	4
65 to 69 years of age	14	4	9	3	2
70 and over	3	0.8	3	0	0

[a] T: therapeutic
[b] N.T.: non-therapeutic
[c] Undetermined

As has been seen above (footnote 2), if allowance is made for the age pyramid the percentages between 0 and 2 must be scaled up or down.

The absence of juvenile addiction is reassuring: in eight years, there were only two cases under 20 years of age, whereas in certain countries, the United States in particular, the use of narcotics by adolescents has gained ground at an alarming rate.

The difference of 10 years between the peaks of the curves relating to men and women is characteristic. It appears to be due to the following causes:

Painful illnesses occur at an earlier age among women than among men.

The ages 35 to 39 in women and 45 to 49 in men mark a turning point in life. Younger women and men will normally seek to rebuild their lives after setbacks of a social or emotional nature. On the other hand, women of 35 and men of 45 who start their lives afresh display a moral courage which makes it highly probable that they will resist the mirage of narcotic drugs.

Comparison of the origin of addiction for each age group shows, as is logical, that for both women and men the ratio of therapeutic origin to non-therapeutic origin tends to increase with age (see table no. 1).

II. ANALYSIS OF CASES OF ADDICTION IN THE DEPARTMENT OF THE SEINE

A. *Analysis of female cases: 412*

(*a*) Origins:

124 of therapeutic origin, i.e., 40 per cent of known origins,

188 of non-therapeutic origin, i.e., 60 per cent of known origins,

100 of undetermined origin.

The cases of therapeutic origin are therefore appreciably more numerous among women than among men (34 per cent). However, the difference is too small to justify any definite conclusion. It may be due simply to the fact that there are more sick women than men.

(*b*) Sources of supply:

Legal traffic	189
Illicit traffic	186
Both concurrently	53
Undetermined	4

(*c*) Recidivists:

138, i.e., 33 per cent.

(*d*) Addicts engaged in drug traffic:

50, i.e., 12 per cent.

(*e*) Divorced women:

The vital records of women offenders show whether they are divorced or not. We were struck by the number of divorced women—104, or 25 per cent. Since divorce does not indicate a harmonious or at least a well-adjusted life, it is not surprising to find so high a proportion of divorced women addicts.

(*f*) Occupations:

The 412 cases are distributed as follows:

Undetermined	10
Women of no occupation	253
Including:	
Prostitutes	90
Unmarried women	50
Married women	113
Women having occupations	149
Including:	
Artists	40
Medical, etc.	39
Including:	
Medical practitioners	2
Nurses	15
Sickroom attendants	4
Midwives	2
Medical secretaries	2
Social assistants	2
Daughter of medical practitioner	1
Wife of pharmacist	1
Wives of medical practitioners	10
The other occupations are as follows:	
Shopkeepers	21

Office employees	19
Liberal professions	12
Domestic servants	8
Cafe-owners	5
Manual workers	5

Thus there are fewer addicts among working women. For such a comparison to be strictly valid, however, the general ratio of working women to the total female population of Paris would have to be known.

In the category "women of no occupation", married women should be separated off. There thus remain 140 who are in fact women of no occupation, including 90 who are known to be prostitutes. The latter thus form the most numerous group. The proportion of prostitutes indulging in narcotic drugs is not, however, considerable; the number of prostitutes in the Paris area is estimated at 25,000.

In subdividing the category "women having occupations"—as was considered essential—the criterion applied was "mode of life". This explains, for example, why the authors have included wives of medical practitioners in the group "medical, etc.". In evaluating these data the numerical size of the groups chosen should be borne in mind. We do not possess precise figures for these, but their general order of magnitude is a matter of common knowledge.

Thus, it is obvious that most addicts are to be found, proportionately, in medical and artistic circles. Since the utilization of narcotic drugs for therapeutic purposes, therefore, the medical profession has paid a heavy toll to drugs. As for the artistic world, that is well known to number many initiates of "artificial paradises". Proselytism also plays an important role here, as may be seen from tables no. 3 and no. 5.

However, the statistics at present by no means cover all drug-addicted artists. A film director who was planning a film dealing with drug addiction received 60 applications from actors asking for the part of the drug addict. They all claimed in support of their applications that being or having been addicts they were eminently qualified to play the role. Yet only 40 artists have been discovered amongst male addicts in 8 years!

Similarly, members of the medical professions have facilities for obtaining supplies of drugs, and are in a better position to escape supervision, however strict.

The existence of drug addiction among the poorer classes will also be noted. It is commonly held that narcotics are a monopoly of the idle rich. This view is out-of-date.

We shall now examine the female cases in detail, on the basis of the chosen criteria (tables no. 2 and no. 3).

Table No. 2

SEINE: WOMEN OF NO OCCUPATION, 263

	Origin of addiction			*Source of supply*						
	Th.	*N. Th.*	[a]	*L.T.*[b]	*I.T.*[c]	*Both concurrently*	*Undetermined*	*Divorced women*	*Recidivists*	*Addicts and traffickers*
Undetermined: 10	2	1	7	6	3		1	?	0	0
Married: 113	46	41	26	58	48	6	1	17	25	8
Unmarried: 50	16	19	15	28	17	4	1	25	16	5
Prostitutes: 90	7	67	16	10	46	34	0	25	59	28
TOTALS: 263	71	128	64	102	114	44	3	67	100	41

[a] Undetermined. [b] L.T.: legal traffic. [c] I.T.: illicit traffic.

Table No. 3

SEINE: WOMEN HAVING OCCUPATIONS, 149

	Origin of drug addiction			*Source of supply*						
	Th.	*N. Th.*	[a]	*L.T.*	*I.T.*	*Both concurrently*	*Undetermined*	*Divorced*	*Recidivists*	*Drug addicts and traffickers*
Artists: 40	8	26	6	13	23	4	0	10	9	6
Medical, etc.: 39	22	7	10	38	1	0	0	9	8	0
Shopkeepers: 21	7	9	5	8	9	3	1	7	7	3
Office employees: 19	4	8	7	10	8	1	0	5	4	0
Liberal professions: 12	4	5	3	7	5	0	0	3	2	0
Domestic servants: 8	3	4	1	6	2	0	0	1	3	0
Cafés: 5	2	0	3	2	3	0	0	1	1	0
Manual workers: 5	3	1	1	3	1	1	0	1	4	0
TOTALS: 149	53	60	36	87	52	9	1	37	38	9

[a] Undetermined.

There are marked differences between the total figures for "women having occupations" and "women of no occupation":

	Women of no occupation (Per cent)	*Women having occupations (Per cent)*
Therapeutic origin	36	47
Non-therapeutic origin	64	53
Recidivists	38	25
Drug addicts engaged in drug traffic	16	6

In the case of women with occupations the figures for the two origins are roughly similar, while in the case of women of no occupation the non-therapeutic origin is predominant. The percentage of recidivists and traffickers is much higher among women of no occupation.

The same situation may be noted in the case of men, and it may be considered—and is generally admitted—that the exercise of an occupation provides less favourable ground for drug addiction than idleness.

Prostitutes account for most of the non-therapeutic cases. In many cases they get their supplies from the black market.

The same considerations apply in the case of artists.

It should be noted that cases of persons obtaining supplies from the legal market are more numerous than cases of therapeutic origin.

Generally speaking, drug addicts who have been introduced to narcotic drugs through therapeutic treatment try to obtain supplies on the legal market; they always regard them as a medicine. Few of them would ever think of obtaining drugs in the streets.

Lastly, prostitutes account for more than half the number of drug addicts engaged in traffic. This occurs partly as a kind of solidarity; they lend each other a helping hand in case of need.

B. *Analysis of male cases: 356*

(a) *Therapeutic origin:*

100 cases were of therapeutic origin, i.e., 34 per cent of the known cases;

192 were of non-therapeutic origin, i.e., 66 per cent;

64 were of undetermined origin.

(b) *Sources of supply:*

Legal traffic, 155
Illicit traffic, 163
Both concurrently, 38

(c) *Recidivists:*

98, i.e., 27 per cent

(d) *Addicts engaged in drug traffic:*

55, i.e., 15 per cent

(e) *Occupations:*

Undetermined	10
Men of no occupation	100
Men practising occupations	246
Including:	
Physicians	56
Artists	40
Shopkeepers	30
Office employees	26
Industrialists	23
Liberal professions	18
Para-medical professions	12
Manual workers	12
Armed forces	11
Cafes — hotels	9
Students	5
Landowners	4

Twenty-nine per cent of male drug addicts have no occupation. The proportion is a considerable one, but a large part of this group consists of individuals of a kind peculiar to large cities, who frequent the shady circles known as *le milieu*. However, another part, comprising 39 per cent, consists of persons who have lost their employment because of drug addiction.

As may be seen from table no. 4 most addicts engaged in drug traffic (41 out of 55) belong to the group "men of no occupation".

So far as concerns men practising occupations, the observations made in connexion with women remain valid. It may be noted that the physicians number fifty-six, or over 15 per cent. Allowing for their size, the groups shopkeepers, industrialists and liberal professions are far more affected than the manual workers and office employees. The members of the armed forces are all colonials who were introduced to opium in the Far East. The four landowners might well be classified among the industrialists in view of their mode of life, since they are large landowners living in Paris. Lastly, five students were victims of proselytism.

The relevant details are given in tables no. 4 and no. 5.

Table No. 4

SEINE: MEN OF NO OCCUPATION

	Origin of drug addiction			*Source of supply*				
Number	*Th.*	*N. Th.*	[a]	*L.T.*	*I.T.*	*Both concurrently*	*Recidivists*	*Drugs addicts*
Undetermined: 10	4	3	3	5	4	1	0	2
No occupation: 100	19	60	21	34	45	21	51	41

[a] Undetermined.

Table No. 5

SEINE: MEN PRACTISING OCCUPATIONS, 246

Occupations	Origin of drug addiction			Source of supply			Recidivists	Drugs addicts
	Th.	N. Th.	[a]	L.T.	I.T.	Both concurrently		
Physicians: 56.....	30	12	14	50	6	0	2	0
Entertainers: 40.....	8	25	7	8	29	3	8	2
Shopkeepers: 30.....	11	16	3	12	14	4	8	2
Office employees: 26....	4	18	4	10	12	4	9	2
Industrialists: 23.....	7	13	3	8	13	2	5	0
Liberal professions: 18	9	8	1	9	9	0	8	2
Para-medical professions: 12.....	2	7	3	9	3	0	2	2
Manual workers: 12....	5	5	2	8	4	0	4	0
Armed forces: 11.....	1	8	2	2	9	0	0	0
Cafes — hotels: 9.....	0	8	1	0	7	2	1	2
Students: 5.....	0	5	0	0	5	0	0	0
Landowners: 4.....	0	4	0	0	3	1	0	0
TOTAL: 246.....	77	129	40	116	114	16	47	12

[a] Undetermined.

As in the case of women there are marked differences between persons with occupations and those of no occupation.

	No occupation (per cent)	With occupations (per cent)
Origin:		
Therapeutic	24	37
Non-therapeutic	76	63
Recidivists	53	19
Addicts engaged in drug traffic.....	41	5

Although non-therapeutic origin is predominant among men also, it is more common among men of no occupation. As in the case of women, the latter account for the highest proportions of recidivists and traffickers. However, it is more difficult for men than for women to obtain supplies on the legal market. There are several reasons for this; among them the fact that most of the female cases are of therapeutic origin and that women can more easily simulate illness and obtain medical prescriptions from doctors out of weakness or indulgence.

III. COMPARISON WITH CANADA

The absence of statistical data on drug addiction was emphasized at the beginning of this study. It is therefore difficult to compare the situation in France with that in other countries. However, an official study covering the years 1930-1946[5] has been made by the Canadian Department of National Health and Welfare. Unfortunately it deals only with persons convicted for offences committed under the opium and narcotic drug act and, consequently, the statistics include not only drug addicts but also individuals convicted on charges of trafficking. The author estimates that drug addicts account for 40 to 70 per cent (the figure varies from year to year) of all offenders. Subject to this reservation a comparison may be essayed at certain points.

In sixteen years 3,245 offences were recorded, including second or repeated offences, i.e., an average of 191 per annum. The sex distribution was 88 per cent men and 12 per cent women. However, the report emphasizes that this does not reflect the real sex distribution of drug addicts. It states that in this connexion the only reliable information is that relating to the admission of drug addicts into mental institutions, the figure for the period 1932 to 1945 amounting to 374 men and 187 women, or 67 and 33 per cent respectively. But these statistics, in view of the small number of cases covered, do not reflect the real position. The authors share the opinion of those experts who consider that in the case of drug addiction of therapeutic origin, at least, the number of women exceeds the number of men; we have already seen that this is the case in France.

On the other hand, we were struck by the age distribution (see table no. 6 below drawn up by G. H. Josie and figure 3).

[5] Gordon H. Josie: *A Report on Drug Addiction in Canada*, Department of National Health and Welfare, Ottawa. 1949.

Table No. 6

DISTRIBUTION OF DRUG ADDICTS IN CANADA

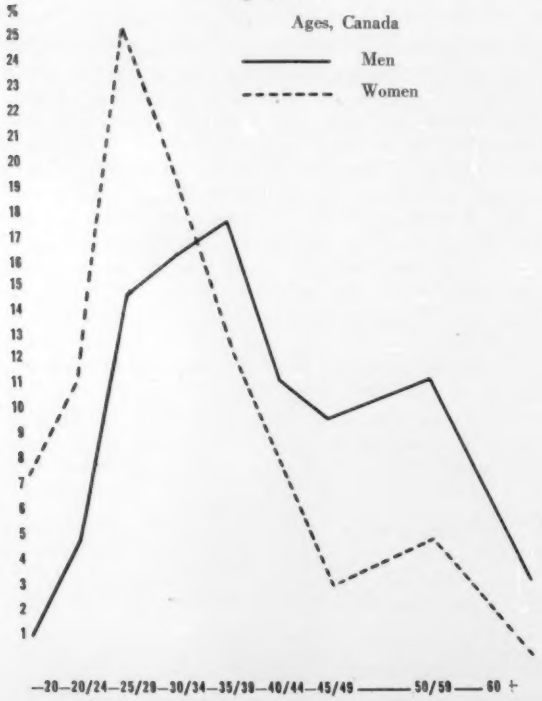
Age-groups	Males		Females		Total	
	No.	*Per cent*	*No.*	*Per cent*	*No.*	*Per cent*
16 — 18 years	10	0.74	2	0.72	12	0.73
19 and 20 years	6	0.44	19	6.88	25	1.53
21 — 24 years	69	5.07	31	11.23	100	6.11
25 — 29 years	202	14.85	70	*25.36*[a]	272	16.62
30 — 34 years	223	16.40	54	19.57	277	16.93
35 — 39 years	240	*17.65*[a]	36	13.04	276	16.87
40 — 44 years	156	11.47	23	8.33	179	10.94
45 — 49 years	134	9.85	9	3.26	143	8.74
50 — 59 years	156	11.47	14	5.07	170	10.39
60 years and over....	46	3.38	1	0.36	47	2.87
Age not given	118	8.68	17	6.16	135	8.25
TOTAL:	1,360	100.00	276	99.98	1,636	99.98

[a]Author's emphasis.

In figure 3 the peaks of the two curves of the graph show a difference of ten years, *as in France*. But the peak age groups are ten years younger than in France (25-29 years in the case of women and 35-39 years in the case of men).

What can be the reasons for the relatively early incidence of drug addiction in Canada? It is difficult to suggest an answer to this question, for without a profound familiarity with conditions of life in Canada highly important factors may well be overlooked.

Figure 3



From partial information collected in the United States it would appear that the situation there is similar. The percentage of drug addiction cases of therapeutic origin is much lower than in France, and a comparison between the curves for Paris and Canada confirms that the flattening of the curves towards the highest age groups is mainly due to the therapeutic origin of the drug addiction cases.

Any serious study carried out in this field should be of a social nature, bringing out the differences between France on the one hand and Canada and the United States on the other hand.

In order to explain the development of drug addiction in Canada, the author of the report quotes Dr. Adams, who says that people take drugs in order to "temper the wind of reality".

The occupational data given in the report are practically useless for our purpose owing to the categories used.

We may note the relatively high number of labourers (21 per cent of the total) and servants (18 per cent).

No comparison can be made in other categories, such as construction, transport and communications, manufacturing, finance and insurance, etc.

There are no figures for medical practitioners or artists.

On the other hand, statistics are given on the education of offenders. They are difficult for us to interpret as we are not familiar with the categories applied.

Table No. 7

DISTRIBUTION OF DRUG ADDICTS IN CANADA ACCORDING TO EDUCATION

Educational status	*Convictions under Opium and Narcotic Drugs Act*		*All convictions*	
	No.	*Per cent*	*No.*	*Per cent*
Superior	90	4.15	6,233	1.34
High school	67	3.09	14,024	3.00
Elementary	1,753	80.86	415,894	89.10
Illiterate	111	5.12	4,958	1.06
Not given	147	6.78	25,649	5.50
TOTAL:	2,168	100.00	466,758	100.00

This analysis shows, at all events, that drug addiction in Canada is by no means confined to the highest social classes.

The report also contains statistics on the religion of offenders.

The most numerous group absolutely consists of Roman Catholics, accounting for 34.96 per cent; however, the Protestants are divided into a multitude of sects: as a group they actually account for 42 per cent. These figures cannot be evaluated without relating them to the religious distribution of the population as a whole, which unfortunately, is not given. However, the proportion of Jewish offenders, 4.9 per cent, is undoubtedly much higher than the relative size of the Jewish population of Canada. The author rightly points out in this connexion that offenders under the Opium and Narcotic Drugs Act are mostly town dwellers, and that 87 per cent of Canadian Jews live in towns. Persons of no religion account for 1.06 per cent of the total. The author states that the proportion of offenders who are members of the Anglican, Baptist, Catholic and United Church groups is lower than their proportion of the population.

The author of the report ends his conclusions with the following words:

> "There is some suggestion that a definite religious affiliation of some kind makes it less likely that a person will become a narcotic offender, but the causal relationship here is not clear since the break with formal religion may be associated with other social factors."

The data given in the report are therefore insufficient to allow of their discussion in this study.

Of the total of 3,245 offences, 1,899 were first offences, 302 were second offences and 1,044 were reiterated offences.

Moreover, the report provides no information on the etiology of drug addiction, merely citing the views of a few international experts.

IV. SUBSTANCES USED BY DRUG ADDICTS IN FRANCE AND METHODS OF ABSORPTION

A. *Substances used*

Allowing for multiple uses, 694 cases of the consumption of narcotic drugs were recorded. They may be classified as follows:

	Number	*Per cent*
Heroin	243	35.1
Morphine	196	28.2
Dihydrooxycodeinone[a]	80	11.5
Opium (smoking)	62	9
Pethidine hydrochloride[b]	52	7.5
Laudanum	31	4.4
Cocaine	21	3
Indian hemp (smoking)	9	1.2
	694	99.9

[a] Sold under the following trade-names: Eubine, Pancodine, Eucodal, etc.

[b] Sold under the following trade-names: Dolosal, Demerol, etc.

Heroin easily heads the list and together with morphine accounts for about two-thirds of the cases.

The high percentage for Dihydrooxycodeinone should be emphasized. This substance, which began to be used in France only a few years ago, has proved to be particularly dangerous with regard to drug addiction. It seems to act more like heroin than like morphine. Similarly the use of Pethidine hydrochloride has already led to a fair number of drug addiction cases.[6]

The *opium smoking* addicts in France are mainly Orientals who have settled in our country and a few idle rich who were introduced to opium by a stay in the Far East.

Every year the police regularly arrest the gang of traffickers who supply the few dozen opium smokers in Paris, but new suppliers always come forward to take their place. The quantities of opium consumed are very small and it is very difficult to prevent clandestine imports. In view of the high price that rich addicts are always prepared to pay, there is naturally a supply adequate to satisfy the demand.

It would be a mistake to judge the extent of this type of drug addiction in France by the newspaper headlines reporting such cases.

In actual fact, the repressive measures taken by the police prevent the operation of any real opium smoking establishments.

Smokers generally indulge their vice at home, alone or with a few intimates. There is thus little danger of this practice assuming dangerous proportions.

Cannabis is smoked almost exclusively by North Africans who receive it in parcels sent by their families. Accordingly, it is difficult to put a stop to this illicit source of import; but here again the practice is a very limited one and there is nothing in France comparable to the vogue of Indian hemp, under the name of *marihuana*, in the United States.

The percentage of *cocaine* consumption (3 per cent) clearly indicates a downward trend, which it may be noted goes hand in hand with a relative decline in the therapeutic use of this drug. The "snow" period seems to have come to an end in France, but not, it appears, in other countries.

[6] In 1953, 16 per cent of the new drug addicts in France and 12 per cent of the recidivists used pethidine. This trend is becoming more marked.

Drug addicts consume *laudanum* by injection, as has been proved by several recorded cases of tetanus accompanied by numerous multiple abscesses caused by injections of laudanum.

Here again, we are a long way from the vogue, dear to Thomas de Quincey, of laudanum taken orally.

The discovery of this practice has led to the suppression of all exemptions granted in respect of laudanum, in particular, the privilege of obtaining 5 grammes without a prescription. It has been found necessary to abolish this allowance whatever the form in which the laudanum is supplied—a French patent medicine for use in compresses containing a high proportion of Ipecac which was supposed to prevent its absorption by mouth was found to be taken by injection.

The foregoing definitely confirms an already well-known fact: that heroin is the most dangerous drug.

B. *Methods of absorption*

The methods of absorption of narcotics by drug addicts were determined in 386 cases. They may be classified as follows:

	Cases	*Percentage*
By injection	325	84
Through the nose	27	7
By suppository	19	4.9
By mouth	13	3.3
By rectal injection	2	0.5
	386	99.7

The prevalence of the transcutaneous method is overwhelming. This is due not only to the efficiency of this method, but also to the "syringe complex" noted by certain authors.

In the past few years *intravenous injection*, which seems to have been quite exceptional before the war, has made considerable strides.

P. Desclaux, L. Derobert and R. F. Katz[7] attribute the development of this method since 1940 to the "increasing scarcity of the drug in ampoules" and to "the idea, inaccurate though it may be, that intravenous injection produces a more lasting effect, permitting smaller quantities to be used so that the stock of the drug can be conserved. The habit has remained, although the first reason no longer exists and drug addicts have been able to convince themselves that the second is false." But the same authors also give a third explanation: "Of course, the main consideration is no longer parsimony; what is sought is a more intense effect and initial sensations of greater coenesthetic euphoria. These, however, do not last longer, as addicts originally thought; on the contrary, they are shorter."

Drug addicts do in fact report that this method produces a more intense effect; and we are obliged to believe them, since that alone can reasonably explain the use of intravenous injection, a more difficult method than subcutaneous or intramuscular injection.

It should also be noted that subcutaneous and intramuscular injections quite often cause abscesses, whereas these are generally avoided by the use of intravenous injection.

The *nasal method* is found almost exclusively on the clandestine market properly so called, where heroin is generally sold in the form of salts.

A new method of absorption has appeared in the last two or three years with the development of *suppositories* for therapeutic treatment. Although this method of absorption is very recent, its effectiveness is proved by the appreciable percentage of cases already recorded.

Under certain exceptional provisions in force in France, limited quantities of suppositories containing narcotic drugs may be supplied without a prescription. When these provisions were introduced, it was thought that the quantities which could be absorbed by this method were limited, in view of the physical effect of suppositories and the volume representing an active dose for a drug addict.

That is not the case: most drugs have a constipating effect, and volume has not constituted the obstacle anticipated. In one case, for example, it was estimated that a drug addict had succeeded in obtaining and "absorbing" an average of 30 to 40 suppositories per day.

The information collected on this subject by the vice squad in Paris shows that many inveterate drug addicts, well known to the police, have completely adapted themselves to this method.

V. Responsibilities of the medical profession

We have had the opportunity of studying the medical records of 574 of the 768 Paris drug addicts. This information comprised in each case the curriculum vitae of the addict, his clinical record and an estimate of his addiction.

These records were all drawn up by the same observer, the Chief Medical Officer of a psychiatric hospital of the Seine Department, and constitute a homogenous mass of material which is unique in France in its quality and size.[8] They provide data the value of which may be judged from the following:

Of the 574 drug addicts:

275 were supplied by medical prescription; yet the medical expert found only 52 sick persons among them, and considered moreover that treatment by narcotic drugs *was justified for only 10 of them.*

148 cases were of therapeutic origin,

104 cases were of non-therapeutic origin,

13 cases were of undetermined origin,

130 were recidivists, and

31 were also traffickers.

[7] *Aspect d'actualité des toxicomanies in Recueil des Travaux de l'Institut National d'Hygiène,* published by Masson, 1950, volume IV, part 1, pages 437 *et seq.*

[8] We are glad to have the opportunity here of expressing our gratitude and admiration to Dr. Gouriou for the help and encouragement he gave us in our work and also for the competence which he has always shown in this highly specialized field of drug addiction.

Thus, 38 per cent of the drug addicts *supplied by doctors* not only were not suffering from any illness, but had contracted their vice for non-medical reasons. However divided medical opinion may be on the advisability of prescribing narcotic drugs, and however severe the judgment of the expert may be, we are clearly faced here with an important aspect of the prevention of drug addiction. The number of quack doctors who "sell" their heroin prescriptions is very small, and nearly all doctors who prescribe drugs wrongly do so without any personal profit; on the contrary, they bring very disagreeable consequences upon themselves both from their "clientele" and from the public authorities.

The incompetent practitioners are the most dangerous.

Let us take some examples:

C. D. .... "I was suffering from migraine, and Doctor X.... prescribed P....[9] for me."

J. T. smoked opium in the East, and on his return to Europe took up the classic substitute of heroin. He showed the expert a medical certificate reading as follows: "This patient has contracted a reactive opiate addiction *as a result of chronic sciatica*."[10]

P. V. ...., an offender confined in a State hospital: "I suffer constantly, but not to any greater extent here, where I do not receive any drugs."

Mrs. K. ...., an asthmatic: "I must admit that I have had fewer attacks of asthma since I lost the habit." This addict had been treated from 1930; she has not repeated the offence since 1947, in which year she was charged and ordered to undergo denarcotization.

We may observe that Professor Vallery-Radot wrote as follows: "I never give morphine to asthmatic patients; I find that treatment very harmful in nearly all cases."

R. R. .... "At the age of 25 I had a carbuncle and the doctor gave me morphine . . ." R. R. . . . repeated the offence 4 times, in spite of 3 convictions.

Mrs. S. . . . became a drug addict as a result of a pregnancy treated as a hepatic colic. In 1946 she simultaneously consulted several doctors, three of whom did not observe that she was in the seventh month of pregnancy.

X . . . became a drug addict at an early age through proselytism, and was subsequently wounded in the arm during the war. He used his wound as a pretext to obtain prescriptions of drugs. He confessed to the expert, who observed that the scar was even, not painful to the touch and without neuralgic complications: "My arm does not hurt all the time, but I have got into the habit of giving myself injections, in a moderate way, whenever I get a fit of depression."

Mrs. V. M. . . . became a drug addict in 1942 as a result of treatment by morphine—due to a mistaken diagnosis. "I am delighted to have been denarcotized. I should never have been given those shots." She has not repeated the offence since 1946.

There are also some doctors, though they are much rarer, who treat drug addicts with drugs. Here is Dr. Gouriou's appraisal of the case of N. J.:

"In the East, he smoked up to a hundred pipes a day; on landing at Marseilles, no longer able to get his usual ration, he fell ill. The doctor consulted came to the learned conclusion, on the basis of his analysis of the symptoms noted, that he was diagnosing a case of withdrawal pains, a so-called 'craving', and that this well-defined syndrome could be cured by morphine injections. The addict, thus introduced by order of medical authority to an occidental and more modern form of drug addiction, remained faithful to it, save that he exchanged morphine for heroin, the effects of which are similar but twice as intense."

Do you think that these "patients" are grateful?

This is what they say of their doctors:

M. X.: "I went to see Dr. Y. . . . I don't want to pass judgment on him, but I think he is a weak man."

H. D.: "If you only knew how we behave in front of doctors—not at all as we do with you. If they are misguided enough to give us a prescription, we go back in a week. If the doctor gives one person a prescription, he is blackmailed by another who has been given his name, into doing the same; and so he is caught in the web."

Far be it from us to use these examples to evade the physician's problem of pain.

Narcotic drugs are an essential weapon in the therapeutic arsenal, and the struggle against the abuse of narcotic drugs is conducted in France in such a manner as never to interfere with the legal supply of drugs for sick persons.

We consider it absolutely essential that the interests of sick persons should never be harmed in the slightest by either international or national action.

The problem of pain cannot be dealt with within the limitations of this article. What the authors wish to make clear is that though they differ in their philosophies they are agreed that pain is harmful and that it is the duty of the physician to eliminate it. But plain common sense requires that one evil should not be replaced by a greater evil. Of course, that is easier to write than to bring about; but information collected over a period of eight years clearly shows that narcotic drugs are too often prescribed when other treatments could be used —treatments which *would be just as effective*.

Here is a striking example: until 1947, dihydrooxycodeinone was subject to certain exemptions, so that suppositories containing that substance could be issued without a prescription. Abuses of a patent medicine containing dihydrooxycodeinone having been reported, the exemption was withdrawn. The manufacturer protested that this meant discrimination against his suppositories, suppositories with a morphine base being still exempted at that time. He was given evidence of abuse, but re-

[9] Patent medicine based on full-strength extract of opium.

[10] Authors' italics.

mained unconvinced and decided to make a personal investigation. After an objective survey, he reported back that the information given him had fallen short of the truth; for example, he had found cases of narcotic drugs being prescribed *against toothache*!

Diagnosis of many types of chronic pain is difficult, and no one will ever criticize a doctor who prescribes narcotic drugs when in doubt. Before a long-term prescription is written, however, it is essential, first, that every possible check should have been applied, and second, that other methods of treatment should have been tried.

It is a commonplace that patients who are in pain and who may legitimately be prescribed narcotic drugs often ask for more than they need. Here are some examples:

Mrs. A. . . . had been the victim of an accident. She told the expert: "I must admit that I have carried the use of drugs to excess; at first one injection was enough for me."

Mrs. F. C. . . . was given prescriptions for dihydrooxycodeinone in 1945. She was sent to hospital in 1948, stayed in hospital 5 months and left denarcotized. Has not resumed the habit:

"I could no longer distinguish between the pain of 'deprivation' and that of my cardiac condition."

The expert wrote the following opinion on a person suffering from stomach trouble who was charged with drug addiction: "The condition of craving is indeed even more painful than the abdominal attacks, and the combination of the two makes it impossible to report objectively on the development of the abdominal syndrome. The tyranny of the drug is such that the patient exaggerates his physical pain to obtain supplies." All denarcotized addicts admit such exaggeration.

The pain felt in the stumps of amputated limbs is well known. Professor Leriche has written on that subject as follows:[11]

"This is what should not be done:

"The complaints of an amputee who says that his stump is giving him pain should not be taken lightly.

"He should not be made to wait a long time for a careful examination, which alone can shed light on the mechanism of his pain and provide therapeutic guidance.

"*He must not be allowed to become a morphine addict: an amputee addicted to morphine is incurable; however strong-willed he may be, sooner or later he will return to the habit.*"

Disagreeable as the admission may be, it must be recognized that the real origin of many cases of drug addiction is the incompetence of the attending doctor.

Physicians must therefore have the courage not to take the easy way out of drugs to make up for the absence of a diagnosis. For this reason, they must also take care not to fall too far behind in their knowledge of medical progress.

[11] Professor Leriche: *La chirurgie de la douleur*, Paris, Masson and Co., 1940.

At the other extreme, we must cite an argument which some physicians have gone so far as to use. It runs more or less as follows: "I no longer prescribe narcotics because I do not want to go to prison."

We have still to be shown a doctor who has been sent to prison for writing legitimate prescriptions. On the other hand, we could point to many offences in good faith and even frauds committed by physicians which have cost them nothing but a mere courteous admonition. In dealing with a drug addict, the physician should try everything before prescribing narcotic drugs. On the other hand, when the disease requires it he should not hesitate to use a medicine whose beneficial effects have been proved.

VI. The role of the pharmacist

The social importance of the pharmacist cannot be exaggerated. His participation in the struggle against drug addiction is a characteristic example of the part he has to play. It cannot be often enough repeated that the best service that can be rendered to a drug addict is to cure him. The moral degeneration of these unfortunates is such, and the methods they use to satisfy their vices are so variously fraudulent, that the weapons which have to be used to cure them may shock the susceptibilities of some persons. Pharmacists, however, must not forget that it is a question of saving the lives of human beings, and that there could be no nobler purpose to justify the means used.

Once the drug addict has more or less fradulently obtained a prescription, he rushes to the pharmacist. A very heavy responsibility therefore rests on the shoulders of that practitioner; one which he alone must discharge. The poison cupboard in general and narcotic drugs in particular must be regularly supervised by the pharmacist, whether he is a dispensing pharmacist or a manufacturer.

This point may be illustrated by two examples. The first is the case of a pharmacist whose employee ordered narcotic drugs without his knowledge. In the second case, a manufacturer of ampoules had an assistant who regularly obtained ampoules of morphine which he wrote off to "manufacturing losses".

A dispensing chemist must in all cases supervise personally the execution of prescriptions for narcotic drugs. He should check their authenticity and make sure that they are written in legal form. If he is in the slightest doubt, he should telephone the doctor and ask him to confirm the prescription.

The pharmacist should always mistrust:

(1) Generally speaking, unknown clients, especially on closing days;

(2) Prescriptions written by doctors who do not live in his district, or whom he does not know, i.e., whose writing and signature he cannot recognize;

(3) Clients living in distant districts, in large cities, or in a different commune, in other cases.

The Decree of 19 November 1948 has given pharmacists in France an effective weapon by requiring them to ask for identity papers if a client is not known to them. This practice has no disadvantages, since pharmacists are bound to observance of professional secrecy. Moreover, the fact that prescriptions of narcotic drugs must be written in a counterfoil book is a serious obstacle to fraud. But what should a pharmacist do when he is certain that a fraud is being committed—when, for example, he is given a false prescription? He should at once inform his inspector of pharmacies, and meanwhile should avoid filling the prescription.

It may be noted that some pharmacists—fortunately they are rare—have thought to solve the problem by systematically refusing to fill prescriptions for narcotic drugs, for example, under the pretext of being out of stock. This attitude is unworthy of a profession whose members daily have occasion to display their high professional integrity. The pharmacist must not be satisfied with a correctly drawn-up prescription; the exercise of perspicacity will often enable him to discover anomalies.

Here is an authentic example: a client came with a properly drawn-up prescription reading as follows:

Sydenham's laudanum..
Camphorated oil..... } aa 15 gr.

This was at a time when there was a shortage of fats and oils, and many pharmacists had no oil. The client, finding that owing to the shortage many pharmacists could not fill his prescription, was in the habit of coming with a bottle already half filled with oil, until one day the attention of an inspector of pharmacies was drawn to the prescriptions, which were in fact false. The obliging client used to pour off the laudanum and use it for injections.

There is one particular case in which a pharmacist can render valuable service: when he realizes that a client is having narcotic drugs prescribed by several doctors concurrently. His duty is to inform either his inspector of pharmacies or the doctors.

In brief, the pharmacist can play a very valuable part in preventing and combating drug addiction. Many pharmacists in France are aware of this and are playing an important part in the detection of drug addicts. There can be no doubt that the effectiveness of the struggle against drug addiction depends to a great extent on the members of the medical and para-medical professions.

VII. Origins of drug addiction

We now come to the general problem of drug addiction. *Why and how does a person become a drug addict? What are the contributing factors and what is their relative importance?*

Much has been written on this theme.[12]

By making a rough selection amongst this mass of documents it seems possible to distinguish three kinds of hypotheses regarding the psycho-pathological origin of addiction to drugs.

I. First, we give an example of the fantastic extremes to which extra-scientific considerations may lead.

We quote the author's[13] own words in order not to distort his meaning; he draws the following distinction:

"The *morphinomane* is a pervert, a sensualist, of limited intellectual development, an abnormal creature who gives way to the abuse both of heroin and of alcohol. He is to be found among the dregs of society and in the lowest strata of the big cities.

"The *morphinique*, on the other hand, is frequently an exceptional individual who belongs to the highest levels of society. He often excels by his cultivated intellect, his standing in his profession and his mental gifts; he may be a distinguished doctor, a well-known politician, a fashionable writer, or a highly qualified naval officer. He discovers that by a sort of affinity of his constitution, perhaps of his gray matter, he has a predilection for morphine and heroin; he has no desire for other drugs. An injection of morphine, given for medical purposes and not at his own request, reveals, to his great astonishment, the beneficial effects of this drug on his organism, his constitution and his general condition. He learns of his need for morphine by pure chance, and the fact that he acquires a taste for it at the first dose is independent of his own volition. He continues to take it from a need to maintain a neuro-vegetative equilibrium until, through the mysterious phenomenon of habituation, he becomes forever a slave to the drug. The hellish cycle has been closed. Thus a well-known dictum is confirmed: nature makes the *morphinique* and a vital need confirms him in his addiction. It is believed that, unknown to themselves, such persons are subject to permanent disturbances of the 'coenesthetic sense' which can be dispelled only by morphine. It is a surprising fact that, leaving aside the question of habituation, morphine seems to be less toxic for a *morphinique* than for any other person. The *morphinique* lives to a good age and does not die of his addiction. The *morphinomane*, on the contrary, very soon reaches a stage of physical and moral collapse and becomes as repulsive as the leper of old."

The author continues:

"I have reached the conclusion that a complex, varied and often very serious clinical and biological syndrome is created by withdrawal . . . I have also reached the further conclusion that this serious syndrome is observable only in a special class of *morphinomanes* whose numbers are very limited, namely, the *morphiniques*.

"*Morphinomanes* do not suffer in the same way when deprived of morphine; they are more numerous and less interesting." (*sic*)

[12] See especially the interesting bibliography of the article by P. Desclaux, L. Derobert and R. F. Katz: *Aspects d'actualité des toxicomanies*, 25th Congress of Forensic, Social and Labour Medicine, Bordeaux, 11-14 May 1949 (I).

[13] J. F. Hayat: *Morphinomanes et morphiniques — La Semaine des Hôpitaux*, no. 63-64, 25-30 August 1952.

The author himself tells us that these conclusions are the result "of fifteen years of impartial observation", and "of fifteen years of bibliographical research . . .".

This article is full of flagrant errors such as the statement that "morphine does not modify the normal state of the blood",[14] and of contradictions and puerilities such as this: "At present, in the case of an individual who suffers much from the deprivation of morphine, we have only one means of determining whether he is a *morphinique* or a *morphinomane: the test of withdrawal.*"[15]

And further on he says: "We consider that in the case of *morphiniques* withdrawal should not be attempted."

II. The proponents of a second theory elaborate it as follows:

"It seems incontestable that in the process of digestion man utilizes both calorific matter and substances that may be termed expendable. The purpose of these latter seems to be either to stimulate the individual to some extent or to enable him at times to escape into dreams. This need, which is found among every social group and in every latitude, may be regarded as a *deep instinctive tendency.*[16] Drug addiction perverts this tendency and leads to the abuse of these substances which are both exciting and inhibitory.

"Considered under this aspect drug addiction is determined not only by the excessive use of a toxic substance but also by an anomaly or lack of balance in a personality."

Elsewhere the same authors say:

"It is possible to distinguish drug addicts who have no natural predisposition but are in fact attracted to drugs under the influence of external factors. Amongst these latter the importance of the excessive use of emotional traumatism for healing purposes is well known. The professional use of drugs is also highly significant, as stressed by recent works on the origin of alcoholism.

"*Besides this category there are the real drug addicts who deliberately choose to live as they do without the compulsion of any external factor.*"[15]

The same report[16] goes on to say: "A point which has been stressed by many writers is the fact that these patients are incapable of social adaptation" and further on: "This incapacity for social adaptation is only an effect. It is the expression of a profound disturbance of the personality in which various tendencies are unable to harmonize."

For that statement the authors base themselves in particular on a bibliographical study of the psychiatric nosography of drug addiction, where theses put forward by some dozens of authors are noted and where almost the whole psychiatric vocabulary is employed. Generally speaking the psychiatric disturbance precedes the drug addiction and is the basic cause of it.

III. Finally a third theory is summarized as follows:[17]

"The essential effect of narcotic drugs consists in the effacing of painful impressions, whether conscious or unconscious. Physical pain, 'cares and worries', fatigue, feelings of humiliation, sadness, anxiety or despair give place to contentment, serenity, hope, a fugitive and deceptive sense of facility and self-confidence. All cases of drug addiction have their deepest roots in this quelling of an inner malaise, not in the exquisite delights, the incredible refinements of sensibility or intelligence, depicted in literature. The causes of dissatisfaction, discouragement, anxiety and suffering in human beings are unfortunately so diverse, and so constantly renewed that the possibility of effacing or forgetting them, even for an hour, will always offer a marvellous temptation, an illusory and facile paradise.

"But it is also at times a road of no return. If circumstances or an underlying predisposition encourage the individual to repeat the use of the drug, the return to lucidity, to contact with reality, painful enough in itself, is complicated by a secondary effect. Soon, by an apparently biological process (it has been found possible to produce cocaine addiction in monkeys) the absence of the drug creates a diffused organic malaise, a sort of anxious hunger, which is called the craving. This reinforces the causes which were responsible both for the individual's recourse to the drug and for its special effect on him. Irresistibly it drives sufferers to another offence and renders withdrawal excrutiatingly painful, indeed almost impossible if the addict is left at liberty. Very soon a vicious circle takes form: the drug itself calls for the drug, and by force of habituation larger and larger doses only bring increasingly incomplete and ephemeral relief.

"The intoxication—no longer now the subjective impressions produced by the drug but its direct harmful action on the organism—little by little takes deeper root and brings fresh sufferings.

"The craving becomes ever more imperious. Efforts to obtain the drug and the use of it monopolize the addict's time. His pressing irresistible need, together with the continuous anaesthesia, as it might be called, which the drug induces, lead to deplorable acts. To procure the drug, the addict wheedles, implores, lies, robs and brings his family and friends to despair and ruin. He often degenerates completely and sometimes ends up in physical and moral collapse."

We could quote a number of American authors to the same effect; suffice it however to cull from the American experience, the most extensive in the Western world, the following observations in support of this theory:[18]

Adolescents of thirteen to nineteen years of age do not have emotional difficulties or personality disturbances

[14] For example, for the action of morphine and heroin on glycemia, see Ch. Vaille: *Contribution à l'étude des hyperglycémies medicamenteuses ou toxiques*, Paris, 1937.

[15] Our italics.

[16] P. Desclaux, L. Derobert and R. F. Katz—*op. cit.*

[17] Dr. L. Le Guillant: *Les toxicomanies, Pages Sociales*, no. 23, 1947.

[18] See especially the works of Dr. Victor H. Vogel.

sufficiently marked to justify a diagnosis of psychiatric mental disorder. This, of course, does not take into account disturbances caused by drug addiction itself and its consequences.

* * *

Amongst these theories where do our own observations lead us? All the studies we have been able to carry out incline us to the third theory: it is not essential to lay particular stress on the fact that man cannot be isolated from his environment and from nature—as is done by the sponsors of the first two theories quoted. Similarly, such researches as we have been able to carry out have not convinced us that drug addicts are already almost always mentally sick before they acquired the craving. It is undoubtedly true that unbalanced persons are an easier prey to drugs than normal persons; but mental unbalance alone is not enough, nor does it explain all the facts. *Previous mental disease is not an invariable feature of drug addiction.* It is of course only too easy to take the effect for the cause; for naturally it is quite undisputed that a person who has become an addict shows psychic abnormalities and may be considered as mentally unhinged.

It would appear that drugs are never an end, or a beginning, but only a *means*. Consciously or not, what the drug addict seeks is to dull the effects of either a physical or a psychic unbalance (indeed the trouble is almost always both physical and psychic) such as physical or moral pain, anxiety, social maladjustment, inadequacy of any sort, etc.

Unable to achieve a stable balance, the drug addict generally seeks forgetfulness of his misfortune and an escape from life; sometimes, too, he tries to fill the void of a joyless existence. Here are some statements by addicts:

M. V. . . . "Like all of us there is only one thing I want: to lie in bed quietly, have my shots and enjoy not suffering."[19]

M.A. . . . "I started taking drugs because I felt I was different from other people; to put a screen between life as it is and what I am."

M.S. . . . "It's when I have nothing to do that I tend to start taking drugs."

Mrs. O. . . . "I can't deny the pleasure I get from the hour's relaxation a pipe of opium gives me. It lifts me above things and consoles me for the worries of the day. *I would compare it to the relaxation you get from a moment of prayer in church.*"[20]

A.L. . . . "It's the feeling; it's a sedative for your anxieties and worries. *I really smoke for no reason at all.*"

Later on the effect itself becomes the cause: whatever the reasons that led to the addiction and even if they disappear, *the addiction remains*. Moreover, very often it runs ahead of its causes. The addict then suffers most of all from the state of craving, and the only remedy he knows is the drug.

Two elements go to produce the phenomenon of "addiction": there must be the individual, i.e., the drug addict, but there must also be the drug. This commonplace is very often overlooked.

There is probably not a single person who, subjected to fairly prolonged treatment with drugs, would not become an addict.

No one is entitled to make any prediction about a case of drug addiction until he has eliminated the determining element, i.e., the drug.

The cure of an addict depends, then, on the discovery of the reasons which induced him to use the drug. There are no generalizations here; only individual cases.

The quest for euphoria as such is extremely rare. Dr. X . . . , an addict, states in this connexion: "I do not try to achieve euphoria—that is a myth; you only get it at the moment of injection, because *the state of craving ceases.*"[21]

How many artists believe that they find inspiration in narcotics? Here is what M.B., a painter, says: "I take drugs from a need to achieve a sense of well-being, of lightness; then I get habituated and lose all sensation; I increase the doses, and then all I satisfy is the craving."

Dr. M. . . . "You increase the doses in order to escape being left face to face with reality."

Avoiding schematism, we can now, for purposes of analysis, distinguish two main classes of drug addiction:

1. Addiction of therapeutic origin;
2. Other types of addiction.

As we have seen, the former class comprises cases of addiction contracted in the course of medical treatment, cases which in a very general sense are connected with the need for the alleviation of physical pain. For subjects of this kind, drug addiction is only a *harmful habit* not *resulting from any psychic abnormality*.

Cases of the second class originate from causes which undoubtedly lie within the field of psychiatry, but of a psychiatry which must not forget that it is a branch of medicine, and which must in addition be supplemented by a sound knowledge of sociology.

There is nothing absolute in this distinction. A drug addict of the second type may very well make his first contact with the drug on being treated for an illness.

In other words: because of their lack of balance, some individuals offer favourable soil for drug addiction. But this is not a "deep-rooted tendency of the individual"; it is itself conditioned by organic physiological or social factors that must be determined if the patient is to be cured.

With regard to social factors, the authors, at the beginning of this study, brought out objective data relating to the sex and age-distribution of addicts, their occupations and the influence of the social environment.

[19] See P. O. Wolff: *Quelques aspects actuels de la toxicomanie; Journées Thérapeutiques de Paris*, 1950.
[20] Our italics.
[21] Our italics.

Doctors should accordingly take this information into account when they are called on to prescribe drugs.

The authors have no wish to disguise the complexity of the problem: drug addiction may be caused by an infinity of factors. Yet it involves one easily accessible element: the opportunity to procure the drug itself. We repeat, therefore: no drugs, no addiction; a truism, of course, but a pregnant one. It is on this simple idea that the soundest system of prevention must be founded.

In our disturbed age, how many of us would become addicts if we were in contact with narcotics? If we think of the considerable spread of drug addiction caused by the last two world wars, we will readily imagine the catastrophe which would be brought about by any sudden termination of narcotics control. The absolutely essential thing is to do everything possible to ensure that individuals have no contact with drugs. That must be the aim of the public authorities in their effort to combat the clandestine traffic. But it must also be the aim of all physicians, who have the power to dispense drugs; that is one of the many grave responsibilities of their art.

VIII. Drug addiction among doctors

The number of addicts among doctors is high as compared with other groups. Fifty-eight cases were discovered in the Paris area alone. Yet none of them can be ignorant of the effects of narcotics. This has been the position since the use of morphine for therapeutic purposes was first introduced.

Analysis of 35 detailed case reports available to us has shown that 3 doctors were suffering from an illness justifying treatment with narcotics.

Twenty-three had started taking morphine for very questionable medical reasons.

Twelve had no medical reasons.

The most widespread cause is professional over-work; pain takes on alarming proportions when a doctor has to respond to a night-call or to start seeing patients again after an exhausting round of visits. At such a time, to stand the strain, the doctor takes a shot of morphine. "I know what morphine is; just one, that's all, just enough to dope me for an hour." . . . such is the downward path leading to a ruin worse for a doctor than for anyone else.

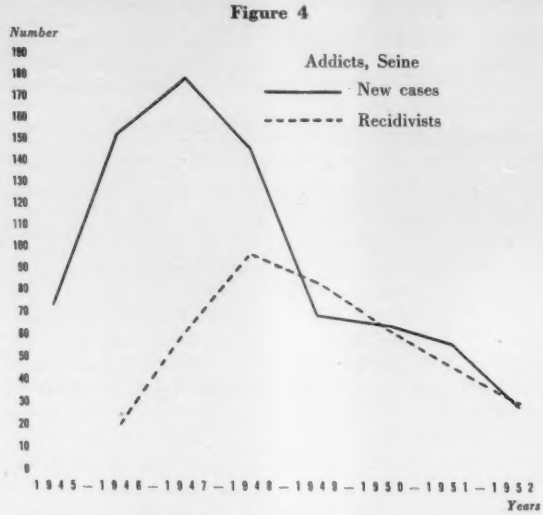
A case in point was that of a doctor who prescribed heroin for almost all his patients, gave them a few useless injections and kept the rest of the ampoules for himself. Another doctor extracted the morphine solution from the ampoules at hospital and replaced it with distilled water.

But this painful problem can be solved only within the medical profession itself.

IX. Recidivism

In conclusion we should like to discuss the problem of recidivism.

Figure 4



The curves in the above graph (figure 4) show that the decline in the number of recidivists is more gradual than that of the number of new cases. This feature is strengthened by the fact that most recidivists relapse after a number of years, and sometimes several times in the same year.

This would appear to be attributable to three causes:

1. A sound system for the control of narcotics and the suppression of the illicit traffic has been in existence in France, particularly since 1946. It operates as an efficient preventive of drug addiction.

2. A large number of denarcotization cures are ineffective.

3. (The most serious factor) Addicts now take special precautions to evade . . . satistical registration.

The problem of the denarcotization cure is very complex. It need only be pointed out here that after a denarcotization cure in a hospital, the patient will inevitably relapse if the causes of addiction continue to exist. Moreover, if the environment is a predisposing factor, as in the case of prostitutes, the same causes will produce the same effects. That point was put tersely by a prostitute whose only excuse was: "I went back to Montmartre", or by another who said: "I stayed for too short a time at La Roquette".[22]

The denarcotization of an addict, therefore, is a long-term task which should be carried out only by a specialized institution with the assistance of the family doctor and the patient's kin.

That view is endorsed by specialists such as Dr. Vogel, who has devoted himself to the cure of addicts, the essential element of which, he believes, is readaptation. Vogel states that the second phase of treatment (after the process of denarcotization in the strict sense) is the most important part of the programme. "Its

[22] Women's prison in Paris.

aims are to restore self-respect and self-confidence, in an entirely new way of life, to make a complete and radical break with the subject's past way of life. The action taken varies according to the needs of each patient. The medical staff must follow the development of the treatment of each subject very closely, and may suggest or prescribe a complementary psychotherapy or rehabilitative treatment when one or the other appears advisable."[23]

Generally speaking, this phase of rehabilitation involves the subject's introduction to a new kind of life, and often, in particular, his apprenticeship to a new trade suited to his aptitudes. At the Lexington (Kentucky) hospital for drug addicts this method has given good results, and the remarkable successes reported in this field show that until all the means already at our disposal have been put into effect any pessimism is unjustified.

Conclusions

Analysis of the cases of addiction brought to light in France, particularly in the Paris area, gives evidence of the important part played in the etiology of drug addiction by the factors of age, occupation and environment.

Although Paris is the centre of the illicit drug traffic in France, and although there exist in the capital milieux especially favourable to the propagation of the drug habit, the proportion of cases of therapeutic origin is very high.

Detailed study of cases of addiction, on the basis of expert medical examination, shows that the abuse of drugs, at least in cases of therapeutic origin, is not necessarily caused by psychic disturbances.

Moreover, it is not established that the mental disturbances noted in certain addicts are characteristic of drug addiction.

The cure of an addict seems to depend directly on the determination of the factors which occasioned his addiction. Such factors are of various kinds: organic, physiological, psychic or social.

However, there remains one element which is susceptible to direct action: the drug, without which addiction cannot exist.

Accordingly, any system of prevention, whether operated by the public authorities or by the medical profession, must begin with the restriction of the use of narcotics to the strict minimum necessary for therapeutic purposes.

Of course, substantial progress is still possible in this field. The responsibility of the medical profession is involved.

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[23] Retranslated from French (Translator's note).

Treatment, Care and Rehabilitation

By Nathaniel L. Goldstein

The United Nations Commission on Narcotic Drugs, at its last session, took cognizance of the importance of the curative and remedial aspects of drug addiction. It adopted, for the first time on the international level, a resolution recognizing the need of governments setting up means for the treatment, care and rehabilitation of drug addicts on a planned and compulsory basis, in properly conducted institutions.

As a member of the United States delegation, I was privileged to pilot this resolution through the Commission and to have been the sponsor of an amendment to Section 41 of the proposed Single Convention, following in the main the pattern of the resolution, with the added proviso that "the programme be adopted in those countries where the seriousness of the problem and their economic resources warrant such measures".

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Attorney General of the State of New York; Member of the United States Delegation to the United Nations Commission on Narcotic Drugs; Chairman of the Committee on Narcotic Drug Control of the National Association of Attorneys General.

As I pointed out in my argument, the nine existing international treaties are essentially concerned with control or preventive measures, although the 1931 Convention contains a provision which appears to suggest an additional approach—that is remedial and curative—the subjective aspect which deals primarily with identification, treatment and rehabilitation.

Public opinion now demands that World governments take not only strong penal steps, in the matter of drug addiction, but also attack the problem from a medico-social point of view. For the problem of narcotics is not susceptible of quick and easy solutions. It has plagued mankind, literally, for hundreds of years.

To bring back the ordinary narcotic user to a life of normalcy, therefore, presents a complex but soluble problem.

It is not enough to confine him in a place where he cannot obtain the drug. His mind and body must both be cured and attuned to a point where there will be neither physical nor mental desire for narcotics. His activities in the community, after he is released from confinement as "cured", must be carefully watched, both for his own sake and for the protection of the public.

Effective cure must proceed in a series of coordinated steps. One is ineffective without the other.

First, physical withdrawal of the drug. In the early or "milk and sugar" stage, it could be accomplished by abrupt withdrawal from the drug, coupled, where necessary, with mild sedation. In the more advanced stage, a gradual withdrawal from narcotics would be necessary. In either case, the treatment could only be accomplished with the patient in custodial care in an institution where each class or stage of addiction could be properly segregated, with due regard for sex and criminal history of the patient.

Second, physical rehabilitation. Here the user would be afforded the medical and physical care necessary to alleviate the damage which the drug may have inflicted on his body. In the main, this, too, is part of the treatment which must be given while the patient is in custodial care.

Third, psychotherapy. This phase of the treatment must be available during custodial care. The causes which lead the user or addict to partake of narcotics must be analysed and removed. In the process, it can readily be determined whether, and to what extent, post-institutional psychotherapy should be made available to the individual patient.

Fourth, occupational therapy. Treatment through specific forms of exercise and work, after initial withdrawal from the drug, is essential to the promotion of effective rehabilitation. A programme of occupational therapy must be afforded while the patient is in custody.

Fifth, after care and follow-up. Past experience has proven beyond any doubt that many users, despite all the efforts expended in the institution, will return to narcotics unless they are protected by an adequate after care and follow-up programme when they are returned to the community. From a practical viewpoint, it is obvious that adequate post-institutional care will also effect a substantial reduction in the amount of time which the patient must spend in custody, and make the facility available for other needy patients.

On still another point do we find expert opinion in unanimous agreement—provision must be made for mandatory treatment of the user or addict. It is not enough to make facilities available; both for his own good and for the protection of the public, the user of narcotics must be quarantined and compelled to submit to treatment or isolation. Both the initial treatment at the institution and the post-custodial programme must be made mandatory and not left to the option of the addict.

The proceedings must not be made criminal in nature and the commitment for want of a better term, does not assume the character of punishment for an illegal act. The after care, although in the nature of parole, must similarly be mandatory, even though in no sense criminal.

This five point programme and the methods of admitting patients are not to be considered immutable laws but rather as standards subject to variations suggested by experience. At the same time it must be emphasized that these standards have been designed with the best expert counsel, as a result of an investigation and study which I conducted in New York State under legislative mandate, in the years 1951 and 1952.

On one point, we are clear. The so-called narcotic clinic, which comes to life periodically, as the bold new plan for dealing with the drug menace is not new, but an impractical idea which was considered, tried and abandoned in the United States over a quarter of a century ago. Its life was short not only because it was found ineffectual, but because it charted a dangerous course toward increased addiction. The following extracts taken from a Report on Narcotic Clinics in the United States, published by the United States Government Printing Office in 1953, tells the tale.

> "During and after the year 1919, forty-four or more narcotic clinics or dispensaries were opened by municipal or State health officials in large cities throughout the United States in an experiment which it was thought might present a simple and easy solution of the problems arising from narcotic drug addiction. Drugs were sold to addicts at prices as low as 2 cents a grain. * * *"
>
> "The clinics were operated for varying periods and in one city as long as 4 years. The most comprehensive series of facts, having real scientific value, that had then been compiled anywhere in the world, was embraced in the published statistics gathered from analytical study of the nearly 8,000 cases of addiction registered and cared for in narcotic clinics during about 10 months by the Department of Health of the city of New York. These cases were subjected to most careful observation and study by specialists qualified to make scientific analysis and arrive at sound conclusions. They reported, 'We have given the clinic a careful and thorough as well as a lengthy trial and we honestly believe it is unwise to maintain it any longer.' * * *"
>
> "By the end of 1925 all of these clinics had been closed by the various State authorities for the reasons quoted herein.
>
> "In New York City it was stated by the Department of Health that 'the purpose of this narcotic clinic is to provide temporary care for addicts who have been patronizing profiteer doctors and druggists.' The clinics practically eliminated this profiteering practice, but there suddenly mushroomed and thrived in its place a tremendous illicit traffic in narcotics which supplemented and nullified the reduction treatments of addicts in attendance at the clinics.
>
> "In a 1-year period in the early 1920's when these clinics were in operation, the volume of illicit peddling of narcotics reached the point where an incredibly large amount of 71,151 ounces of narcotic drugs was seized in the domestic illicit traffic—or more than 14 times as much as was seized in 1952.
>
> "In New York State alone, when 16 or more narcotic clinics were in operation throughout the State, almost 4,000 ounces of narcotic drugs were seized in illicit channels during a year —or almost as much as was seized in the entire United States during 1952. * * *"
>
> "At Sing Sing Prison in 1920, the number of drug addicts received increased over 100 per cent; in 1922 they increased over 500 per cent; and in 1923 the increase was over 900 per cent.
>
> "In 1922, 20 per cent of the prisoners incarcerated in the Atlanta Penitentiary were drug addicts; at the Woman's Workhouse, Blackwells Island, practically all prostitutes committed were drug addicts; and from 60 to 80 per cent of all committed there were drug addicts.
>
> "This illustrates the situation with regard to crime and drug addiction during the period when the narcotic clinics were in operation. * * *"

The ex-president of the American Medical Association stated:

> "We have found out here (New York City) that the narcotic dispensaries do not relieve the situation, they simply legitimatize the drug indulgence, and it is for that reason that the American Medical Association recently passed its resolution condemning them and the Public Health Service is endeavouring to close them up.
>
> "The chairman of the Medical Society of the county of New York, Committee on Public Health, stated 'all look upon the New York clinic as a positive demonstration that addicts must be under institutional control or any other kind of absolute control. The only hope is cutting off the supply of drugs as completely as possible. Therefore, no public clinics.' "

It is quite obvious that what proved ineffective 35 years ago would certainly be more ineffective today.

In the final analysis, we must not lose sight of the three factors which are vital in the adequate treatment of addiction; (1) The socially contagious nature of the disease; (2) The need for compulsory institutional treatment; (3) The *sine qua non* of mandatory after care guidance.

Addicts become addicts from association; every active addict that is loose is a possible source of infection

for others. To permit the addict to roam the streets while undergoing treatment is to fight a city-wide conflagration with a trickle of water. More will be spread than is put out.

Expert opinion in this field is in unanimous agreement that provision must be made for compulsory treatment and without a mandatory system of after care and guidance the programme can be of no effect.

The five point programme of treatment, care and rehabilitation represents not only the consensus of expert opinion on the subject of drug addiction, but, of even greater importance, is evolved from trial and admitted error in other facilities.

To achieve ultimate victory, governments must be patient. So ancient and evil is the problem that a thoroughgoing coordinated attack requires planning and development. There is no time to wait for the formulation of a perfect plan. Within their limitations, and with such weapons as are available, governments must start now and not depend upon a tomorrow.

Some Aspects of the Social Medical Problem as seen by the General Practitioner

By Professor Demetrio Mayoral Pardo, M.D.

Director-General of the Department of Health and Welfare of Mexico

The problem of drug addiction is extremely important nowadays, because of the very various factors, chiefly social and economic, which produce individual and collective moral disorders. It is therefore imperative that the general practitioner should be acquainted with the core of the problem, the pathogenesis of addiction and the complex of phenomena of which it is composed, so that he may be able to deduce measures of prevention and cure.

Before entering into the substance of the matter it may be useful to define some terms. Cardenal defines the Spanish word *toxicomanía* (drug addiction) as "an irresistible urge towards poisons, in particular narcotic substances". *Hábito* (habit), he says, is a custom or practice acquired by frequent repetition of the same act, and *habituación* (habituation) is gradual adaptation to a stimulus or to the environment.

The definition of the word *toxicomanía* essentially implies a substance which enslaves, an uncontrollable desire for it, and an increasing tolerance of its effects. Tiffeneau suggested, to express slavery to a drug or poison, the term *asuetud* (habitude, addiction); this is better because it avoids the word "*manía*" (mania, madness), which rather has the meaning of mental illness or excessive preoccupation (e.g., erotomania, dipsomania). "*Toxicomanía*" would thus be distinguished from "*acostumbramiento*" or "*habituación*", which imply that a person is habituated or used to a drug but not dependent upon it as a necessity.

Aristotle said that habit or use was a type of behaviour of a permanent nature. By repetition it tends to become automatic, and thus the repeated use of an organ or function in a particular way and the repeated performance of an act or operation give rise to a habit.

The World Health Organization's Committee of Experts on Drugs liable to produce Addiction probably had similar considerations in mind when it defined habituation (*acostumbramiento*) to drugs as follows:

> "A habit-forming drug is one which is or may be taken repeatedly without the production of all the characteristics outlined in the definition of addiction and which is not generally considered to be detrimental to the individual and to society."

Thus such euphoric drugs as tobacco and caffeine-like substances are included in this category.

The Committee of Experts defines drug addiction (*toxicomanía*) as a state or periodic or chronic intoxication, detrimental to the individual and to society, produced by the repeated consumption of a drug (natural or synthetic) causing:

(*a*) An overpowering desire or need (compulsion) to continue taking the drug and to obtain it by any means

(*b*) A tendency to increase the dose (as a result of tolerance)

(*c*) A psychic (psychological) and sometimes a physical dependence on the effects of the drug (addiction or slavery).

Thus the definition sets forth the characteristic phenomena: tolerance, and physical and psychic dependence. The first concept explains how the addict's organism can tolerate enormous doses, sometimes much greater than the lethal dose; physical dependence enables us to understand the spectacular and sometimes fatal effects (psychosomatic syndromes) of abstinence from the drug. Psychic slavery or dependence results from the characteristic feeling of well-being and euphoria which creates in the patient the irresistible desire to continue to take the drug in ever-increasing doses.

It should be pointed out that strictly speaking the only drugs which should be called drugs of addiction are those which cause addiction without fail, inevitably, when used over varying periods in average doses. For example, tobacco may apear to be indispensable to a smoker, and abstinence from it may cause more or less serious disturbances and disorders; but these depend basically on the individual and his temperament, not on the drug itself. The effects of morphine are entirely different. Any physically or psychically normal person who uses morphine regularly for some time is thenceforward tragically compelled to continue its use, for it has become indispensable to the tissues and cells of the organism. Abstinence, by disturbing the cell-drug balance which has been set up, will cause functional and organic disturbances which are always serious. One might almost say that a drug of addiction acts as a cell constituent—in fact, as an integral part of the organism. This explains the intensity and seriousness of abstinence phenomena.

What, then, are the factors causing the present increase in drug adiction? The answer is, perhaps, that an un-

balanced social structure, terrible economic and social injustices, loss of moral values and disappearance of the sense of responsibility all cause irreversible biological changes in the personality.

To these factors may be added the disrupting impact of the world wars, the tension and anxiety which have marked this post-war period, increasingly-distressing economic problems, and other ills. It is then easy to understand that the degradation of human values and the intensely aggressive temper of this age of haste and anxiety cause an individual who is constantly assailed by harsh reality to yield to the instinct which tempts him into the attractive paths of phantasy opened to him by the drug—which indeed society itself seems to offer him as a discreditable sort of compensation.

Since one of the tendencies of present-day medicine is to look beyond the study and treatment of the individual patient to collective problems, drug addiction should interest all doctors, as well as public authorities and society in general. A doctor therefore needs to know the basic facts about this very disturbing problem and to apply prophylactic measures, which are always preferable to treatments of doubtful value.

Further, the assumption by the State of many social medical problems which used to be dealt with only by doctors and voluntary societies has meant that public health authorities now tackle the problem; but unfortunately they often do so only from the penal or police point of view, without squarely facing the relevant facts of human structure and biology.

They give the impression that society is being protected, but all they do is to isolate the drug addict by unilateral action, wrongly assuming that his addiction to the drug arises out of a moral degeneration which he could remedy by an effort of will. They forget that society itself is responsible to a certain degree, since it has been unable or unwilling to raise the cultural level of all its members. An insolent display of money, frequently ill-gotten, inflames the craving for wealth and material pleasures. This, being frustrated, sets up personal conflicts and serious behaviour problems which tempt the individual to escape into phantasy by means of drugs.

Biological and human discontent, failure to satisfy complex appetites, non-acceptance of pain and suffering, undoubtedly lead the unwary and those lacking in spiritual human values to resort to the artificial paradises provided by alcohol, marijuana, cocaine and morphine.

Many doctors still regard the drug addict only as a nosological entity and do not allow for the biological and social factors which have produced him. That is the traditional attitude and should not exist. In these times drug addiction should be regarded as a genuine social illness, since most of its etiology and pathogenesis consists of disorders produced by civilization and by economic and social inequality in individuals who are discontented, who lack the spirit of struggle and sacrifice, and whose moral values are very defective.

This moral and cultural background of the drug addict is ignored and an attempt is made to appeal to his will and to impose upon him the same obligations as a normal person. Thus treatment fails—not only, be it noted, in poverty-stricken environments such as our own but even in economically-privileged countries like the United States.

I repeat that it is infinitely more desirable to tackle the serious problem of drug addiction, like that of contagious diseases, by prophylactic and preventive measures: that is, to deploy all the resources of the State in a determined attack on the illicit drug pedlars who dominate the susceptible and the addicted.

Medical students should be emphatically warned against the dangers of using drugs capable of causing addiction, and shown how easy it is in most cases to use other analgesic prescriptions in order to avoid such drugs as morphine, the prolonged use of which causes addiction.

It is to be hoped that public health authorities will ruthlessly hunt down illegal traffickers, and also restrict the use of these drugs even for lawful medical purposes.

There should be an international campaign not only to restrict production of drugs causing depression or addiction, but also to abolish most of them outright, as in many countries heroin has been abolished.

Let us hope that before long the pharmacologist, improving on the marvellous laboratory of nature by removing and adding radicals, will finally produce what Professor Pablo Oswaldo Wolff, of the Argentine, has called "eumorphine", so that the doctor, in obeying the divine command to relieve pain, will not expose humanity to the danger of drug addiction.

Mexico, August 1953

TECHNICAL

A Quantitative Method

for the Isolation and Determination of Morphine in Opium and Medicinal Preparations

By I. Grosfeld-Nir, S. Gassner and E. Weissenberg[1]

An assay of morphine in crude opium and medicinal preparations is described, based upon chromatographic purification of the alkaloid, which is subsequently determined volumetrically.

Introduction

In spite of the many methods published on the estimation of morphine in crude opium, there is at present no satisfactory method available which permits quantitative determination of the alkaloid with ease and reliable accuracy.

The methods of assay of morphine in opium given in the majority of pharmacopoeias are based upon lime (1)[2] treatment of sample with formation of calcium salt, its subsequent separation from accompanying alkaloids and other interfering substances and finally, volumetric determination of the isolated morphine. Other methods making use of polarographic (2), colorimetric (3), and ion-exchange (4) procedures, have also been described. Lately, methods advocating adsorption of opium alkaloids onto alumina (5), and florisil (6) columns have been published.

The official pharmacopoeial methods have the disadvantage of being complicated and requiring many time-consuming and tedious manipulations, thus entailing loss of accuracy. (This latter fact is countered in the British Pharmacopoeia by the addition of a factor of ten per cent of the morphine content to the result obtained.)

The main problem in the assay of morphine in opium lies in the difficulty with which it can be separated from the other alkaloids occurring naturally in opium, owing to their similar physical and chemical properties. However, there exist some differences in their solubilities in organic solvents. Data on the different solubilities of opium alkaloids in various organic solvents were published by Klyachkina (7).

From this work we know that morphine is practically insoluble in organic solvents like benzene, ether, etc., whereas the other opium alkaloids are fairly soluble in these solvents.

We therefore attempted to make use of these differences, under well defined and controlled conditions; i.e., by employing chromatography, when it was hoped that isolation of morphine could be achieved.

Our task consisted therefore in finding a simple and practical solution to each of the following problems:

(1) Complete extraction of morphine from crude opium.

(2) Choice of a suitable adsorbent for the extracted alkaloids.

(3) Removal of accompanying alkaloids other than morphine and interfering substances.

(4) Choice of suitable eluting agent for quantitative recovery of purified morphine.

In the following report a short and simple method is described in which the accompanying interfering substances are removed by use of an adsorption column, and the purified alkaloid in the eluate is determined volumetrically.

Experimental work

Extraction

The first step in the determination of morphine consists in its complete extraction from the crude opium. After different procedures such as extraction with acids and alkalies in different concentrations and at various temperatures, and extraction with distilled water only, at various temperatures, were tried out, the technique described below was accepted as the most suitable.

The extraction with acids was found to be unsatisfactory, owing to the simultaneous release of darkly coloured material from the crude opium. The coloured substances could not be separated from the alkaloid in the subsequent chromatographic step.

The alkaline extraction on the other hand yielded a solution containing the corresponding morphinate, which

[1] Government Institute for the Standardization and Control of Pharmaceuticals, Ministry of Health, Govt. Central Laboratories, Jerusalem—Israel.

[2] Figures in parentheses refer to figures in the Bibliography in this section.

proved exceedingly difficult to elute from the chromatographic column in the subsequent stage. Both procedures had thus to be discarded.

Distilled water ensured complete extraction of the morphine present provided extraction was carried out at 60 degrees C for at least two hours. A further rise in temperature or increase of extraction time merely added to the amount of interfering substances also going into solution. On the other hand, incubation at 37 degrees C for 24 hours gave us results similar to extraction at 60 degrees C. However the two hours period of extraction was finally adopted in the described assay.

The completeness of the extraction of total morphine from crude opium by the procedure described above was checked by means of the B.P. and U.S.P. methods for the determination of morphine in opium.

Selection of the adsorption column

A number of substances such as permutite, silicic acid, alumina, celite, mixtures of celite with alumina and celite with magnesia were tested as to their ability of adsorbing the different opium alkaloids and/or impurities.

These adsorbents were placed into a chromatographic column consisting of a glass tube 280mm. in height and having an internal diameter of 22mm. constricted at the lower end to fit into a holed rubber stopper. Various amounts of adsorbents giving columns from 2cm. to 10cm. in height were packed to different degrees of tightness by suitable application of a vacuum pump. Various amounts of the aqueous extract ranging from 2 to 10ml. were used in these preliminary experiments, which gave the following results:

Permutite adsorbed neither opium alkaloids, nor impurities. Silicic acid adsorbed morphine but did not permit its recovery without simultaneous removal of impurities. When using alumina, it was found that some eluting agents such as ether or benzene removed neither morphine, nor "other alkaloids", whereas solvents such as chloroform removed both morphine and accompanying alkaloids together. Celite was the most efficient and convenient substance to use. Mixtures of celite and alumina or magnesia did not improve the efficacy of the column, the alumina in fact causing undesirable colloidal solutions with the eluting agent.

Celite was therefore adopted as the most suitable adsorbent, six grammes of which were used in the above described chromatographic tube packed tightly to a column of about 80mm. in height. Under these conditions five ml. of the aqueous extract were found to be optimal.

To ascertain the optimum pH for the best separation of morphine from the other opium alkaloids and accompanying interfering substances, a number of experiments were run on columns adjusted to different pH values, by adding one of the following reagents in various concentrations to the aqueous extract before pouring it on the celite: hydrochloric acid, acetic acid, and mono-potassium-dihydrogenphosphate.

Acidic columns were rejected, as the partition of the solutes from the aqueous medium having a pH lower than 7, was found to give unsatisfactory results.

Columns having a pH higher than 7 were found to be much more suitable for our purpose. The addition of 0.3—0.5ml. of concentrated ammonia to five ml. of the opium extract before application to the column proved to permit the desired separation of the alkaloids without difficulty. Equally, by rendering the aqueous phase alkaline with a weak solution of sodium hydroxide, a good separation of the solutes was achieved, but the use of ammonia was found preferable because any traces of this base passing through the column into the eluate could easily be removed before titration by simple heating. Hence, the results of analyses thus obtained were found to be more reproducible.

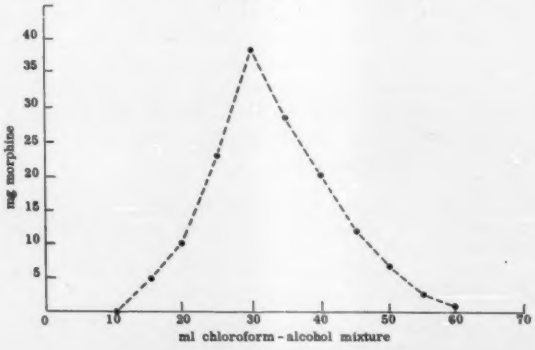
Elution of the opium alkaloids

For the selective transport of the solutes from the aqueous phase the following organic solvents and mixtures were tried out: benzene, ethyl ether, ethanol, acetone, chloroform, iso-butanol, methanol, CCl_4, ether-isobutanol 4:1, chloroform-isobutanol 4:1, phenol 1 per cent in chloroform, chloroform-methanol 3:1 and chloroform-ethanol 3:1 by volume. Of these benzene was found most suitable under the above conditions for the removal of alkaloids other than morphine, and chloroform-ethanol for the elution of the morphine itself, leaving the colouring matter, etc., adsorbed on the celite column. About 100ml. of the chloroform-ethanol mixture was found to be sufficient for the complete elution of the morphine from the adopted Celite column, prepared as described in the experimental procedure. (See figure 1.)

Removal of solvent

From the eluate obtained, containing the morphine, the chloroform-ethanol was distilled off on a boiling water bath. To ensure the complete removal of any possible traces of ammonia, without, however, exposing the residue to any oxidative alteration by excessive heating, we adopted the procedure as described below. Drying of the residue at 100°C. in an oven or under reduced

Figure 1



pressure at lower temperatures did not give better results than simply boiling it on the water-bath. Incidently this latter procedure also caused the traces of colouring matter remaining with the morphine crystals in the residue to become baked together, so that they did not interfere in the subsequent titration of the isolated morphine.

Reagents

Celite No. 545 or 655 (Johns-Manville, diatomaceous earth)

Benzene, A.R.

Chloroform, U.S.P.

Ethanol absolute, U.S.P.

Ammonia solution, U.S.P.

Sodium hydroxide A.R. A N/100 solution is employed, suitably prepared by diluting a N/10 standard solution.

Sodium sulphate, anhydr.

Sulphuric acid, conc. A.R.

Chloroform-ethanol abs. mixture. Mix 3 parts of chloroform with 1 part absolute ethanol.

Shiro-Tashiro Indicator Solution. Mix 2 parts of 0.1 per cent solution of methyl red in 96 per cent ethanol with 5 parts of 0.1 per cent solution of methylene blue in 96 per cent ethanol.

Range:	pH 4.4	pH 5.4	pH 6.2
	blue	dirty blue	green

Recommended procedure

A. *Extraction of the morphine.*

Five grams of finely pulverised opium are triturated in a porcelain mortar with ca.10cc. of distilled water for 15 minutes. The resulting suspension is then transferred into a tared 250cc. Erlenmayer flask with the help of a spraying bottle containing warm distilled water, until the total weight increase is 50 grams. The flask is stoppered and shaken up vigorously for thirty minutes.

The flask is then immersed in a water-bath at 60 degrees C for two hours. The resulting extract is centrifuged at 2000 r.p.m. for ten minutes and the supernatant solution finally filtered through a paper filter (Whatman No. 1) The extract is now ready for the next step.

B. *Separation of the alkaloids on a chromatographic column*

Place five grams[3] into a test tube, add 0.3—0.5ml. of concentrated ammonia, cover with a pad of cotton-wool and shake gently. Remove pad of cotton-wool with a pincette and pour contents of test-tube into the partition column, using the cotton-wool to transfer any particles of precipitated alkaloid adhering to the test-tube walls. Place cotton-wool on the column and press down with a glass-rod. Wash test-tube twice with five ml. portions of benzene each and pour into column.

Fill column with benzene and allow Celite to become soaked. As soon as the first drops of benzene start to drop from the bottom end of the tube, connect receiving flask to a vacuum pump, adjusting the rate of flow to approx. 2 drops per second. A total of about 150ml. of benzene is used for wetting the column and washing out the "other" opium alkaloids.

When practically all the benzene has passed through the Celite column, the vacuum is released slowly (in order to prevent displacement of the Celite column by the sudden formation of back-pressure).

The receiving flask is replaced by a clean vacuum flask and 150ml. of chloroform-ethanol abs.(3:1) is introduced into the column from a separating funnel suspended from the top of the column. The vacuum is again applied to produce the same rate of flow. Note that the Celite must at all times be covered with solvent.

When all but 1-2ml. of the solvent above the Celite level of the column has passed through, the vacuum is carefully released. The eluate is transferred quantitatively to a 400ml. Erlenmeyer flask.

C. *Distilling off the solvent*

The chloroform-alcohol mixture is now distilled off from a boiling water-bath. To the residue in the flask five ml. of absolute ethanol, neutral to Shiro-Tashiro indicator, are added and again distilled off. A further portion of five ml. ethanol abs. are added and the distillation repeated once more. The Erlenmeyer flask is left in the boiling water-bath for an additional 20 minutes to ensure complete removal of any remaining traces of ammonia.

D. *Volumetric determination of the morphine*

Fifty ml. of N/100 H_2SO_4 are added to the residue in the Erlenmeyer flask, and the solution is heated to boiling over an open flame for about 3 minutes. After cooling to room temperature by immersing the flask in ice water, the excess acid is back with N/100 NaOH, using 1ml.[4] Shiro-Tashiro as indicator.

Apparatus

Adsorption column

A small pad of cotton-wool is packed into the constricted stem of the partition tube 280mm. in height and 22mm. in inner diameter. Sodium sulphate anhydr. is added until a layer of about two centimetres thickness is formed. This is kept in place by cotton-wool packed down by a glass-rod.

About 6 grms. of Celite is sucked down to a height of about 80mm. with the help of a glass-rod to ensure uniformity of the adsorbent in the column. Finally a small pad of glass-wool is placed on top of the Celite layer.

[3] For convenience sake take 5ml. and correct for specific gravity of 1.02.

[4] Usually 15 drops were sufficient, but in some cases it was necessary to add additional drops of the indicator to obtain a sharp end point.

Accuracy of method

To determine the accuracy of our proposed method we made up a morphine solution containing 50mg. of the hydrochloride in 5ml. corresponding to 36mg. of the free base. The results of analyses obtained by our method were on the average 35.5mg. falling within the limits of 35.5 to 36.5mg.

Next, several mixtures of alkaloids were prepared, containing in addition to morphine, some of the other naturally occurring opium alkaloids in various proportions. Results of estimation of morphine in such mixtures, and of recovery of a weighed amount added to an opium extract, are given in table I below:

Table I

(A.) Recovery of Morphine from mixtures with other Opium alkaloids

Sample No.	*Weight of Morphine HCl*	*Weight of Morphine calc. as free base*	*Alkaloid added*	*Recovery of Morphine titr. as free base I*	*II*
1.	50 mg.	36.0	Narcotine 20mg.	36.1	35.9
2.	50 mg.	36.0	Papaverine 20mg.	35.0	35.4
3.	50 mg.	36.0	Narceine 20mg.	36.5	36.2
4.	50 mg.	36.0	Thebaine 20mg.	36.2	36.0
5.	50 mg.	36.0	Codeine 20mg.	39.0	39.6
6.	50 mg.	36.0	Mixture of 1-5 above	36.0	36.8
				37.1	37.1
(B.) Recovery of Morphine added to Opium extract					
7.	55.6 mg			56.2	55.8

In the following table, results of morphine estimations carried out on various samples of opium of different origin by our proposed method are compared with results obtained on the same samples with the U.S.P. and B.P. methods.

Table II

Percentage content Morphine

Sample	*Chromatography*	*B.P.*	*U.S.P.*
Turkey I	16.6	16.2	15.5
Turkey II	13.6	13.1	12.3
Turkey III	17.2	18.0	17.6
Turkey IV	15.2	15.5	15.1
Turkey VI	13.0	12.7	12.0
Turkey VII	17.5	17.5	16.9
Turkey VIII	14.9	14.7	13.9
Turkey IX	16.4	16.8	16.3
Turkey X	13.5	12.0	11.2
Turkey XI	13.6	13.5	12.4
Turkey XII	14.8	14.5	13.8
Turkey XV	13.5	14.5	13.3
Yugoslavia I	17.0	17.8	17.6
Yugoslavia II	17.1	15.7	15.2
China I	12.9	10.2	9.5
China II	10.2	8.0	7.7

Discussion

A simple and accurate method for the assay of morphine in crude opium and medicinal preparations is suggested, which is based upon its separation from accompanying alkaloids and other interfering materials by means of chromatography.

The results obtained by this method were found to be reproducible.

The proposed method is equally applicable to medicinal preparations, such as tinctures, extracts and mixtures of alkaloids containing morphine. Where ethanol is present in preparations it has firstly to be removed by distillation before application on to the column. This is easily achieved by driving off the ethanol by partial immersion in a boiling water-bath and then making up to the original volume with distilled water. Traces of ethanol do not interfere.

As to the "other" opium alkaloids which are removed by the benzene: although obtained in a purified state freed from accompanying colouring material and other impurities, they could not be determined volumetrically, as not all of them are stochiometrically titratable.

However, their separation and the isolation of individual alkaloids might now be possibly attempted with promising results.

Summary

1. An assay of morphine in crude opium and medicinal preparations is proposed, based upon chromatographic separation of the alkaloid, which is then determined volumetrically.

2. A simple chromatographic adsorption method has been developed for separating morphine from accompanying alkaloids and interfering substances present in crude opium. The separation system consists of a Celite adsorption column, wetted by an ammoniacal aqueous opium extract. The alkaloids other than morphine we washed out with the help of benzene, whilst a mixture of $CHCl_3$+ethyl alcohol was employed as eluting agent for the isolated, purified morphine.

The proposed method is short, simple, and gives reproducible results.

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Part IIB. X-Ray Diffraction Powder Data for Eighty-Three Narcotics

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Introduction

Relatively few data for the identification of narcotics by the X-ray diffraction powder method are available in the literature. The basic principles and techniques of the method have been outlined in the preceding paper (2)[1] of this group of articles on *Physical Methods for the Identification of Narcotics*. The primary object of the present paper is to provide tabulated data and characteristic X-ray diffraction powder photographs for eighty-three narcotics, including some hydrates and a few optical isomers and their racemoids. At the same time a number of notes on particular compounds, with the investigation of which difficulties or special points of interest were encountered, are included in the hope that they may be of interest to other laboratories.

All samples, with the exception of two protopine preparations, were supplied by Dr. C. G. Farmilo, and their authentication is discussed elsewhere (3).

At least two X-ray diffraction powder photographs were taken of each sample, although, for various reasons, additional ones were obtained in many cases. Whenever possible the product of more than one laboratory or pharmaceutical manufacturer was included. Although the majority of specimens were first crushed and then mounted on the end of a pyrex-glass fibre by means of Household Cement, a large proportion of the duplicate patterns were obtained from specimens taken up in capillary tubes directly from their original containers, thus avoiding any possible effect of mechanical grinding or of contact with the adhesive or its solvent. Furthermore, time intervals of at least a few weeks to more than one year elapsed between photographs of different specimens of each sample so that some opportunity automatically was provided for observing any alteration during storage. More than 300 X-ray diffraction powder photographs were taken during the course of the present investigation. The best pattern for each narcotic (in some cases more than one) was measured at least twice and almost invariably by different individuals.

Experimental

For specimens mounted on the ends of glass fibres, quantities of the order of 0.15 to 0.2 mg. were employed. Each was ground in a mullite mortar, or in a well-type microscope slide with a miniature glass pestle. A small portion of the fine powder was placed on another microscope slide together with separate drops of House-

[1] Numbers in parentheses refer to the list of References.

hold (Duco) Cement[2] and isoamyl acetate. The end of a thin pyrex-glass fibre was touched to the cement and then to the powder. If the cement was too viscous it was dipped in the isoamyl acetate before taking up the powder. By judicious application of the fibre to the cement, isoamyl acetate, and powder, and with the aid of a needle held in the other hand, specimens of suitable size could be built up on the end of the fibre. The whole operation was carried out most conveniently under a stereoscopic microscope.

X-ray diffraction tests of a number of adhesives in this laboratory several years ago led to the adoption of Household Cement because it gives no diffraction lines, and only a minimum intensity of scattered radiation, compared with many other adhesives commonly employed. Since the quantity required to mount a specimen (powder or single-crystal) is very small, no difficulty has been experienced in its use even with organic compounds soluble in acetone. Unfortunately it is supplied only in lead tubes which are intended to be opened by means of a screw that pierces a lead membrane closing a threaded plug in the top of the tube. Abrasion of the threads during this procedure usually contaminates the cement with small particles of lead which results in the diffraction pattern of lead appearing on the film if any of the particles are picked up during mounting of the specimen. Attention recently has been drawn to this fact in the literature (9) where slitting the tube down the side and transferring the contents to a glass container has been recommended. This has been standard practice in this laboratory for the past six years except that the bottoms of the inverted tubes are cut off with a pair of sharp scissors; the tube then opens easily and the cement is poured into a glass jar with screw top. The cement may be thinned with acetone, amyl acetate, or isoamyl acetate; the last has the least rapid rate of evaporation and its use permits a longer time for manipulation when preparing the specimen before the cement hardens.

For the preparation of specimens in thin-walled capillary tubes the following method (10) was employed. The capillary tubes were made by drawing down Corning special glass tubing 7070 (16 mm., outer diameter; 13 mm., inner diameter) and selecting straight sections, approximately 1 to 1.5 cm. long, 0.018 inch outer diameter, 0.001 to 0.002 inch wall thickness.[3] A rubber "policeman" with the oblique blade trimmed to a right angle was fitted to the end of a seven-inch length of glass tubing which was connected by rubber tubing to one arm of a glass Y-tube, the leg of which was joined by rubber tubing to a trap and thence to a water suction pump. The glass tubing carrying the rubber policeman was handled in the same way as a pen or pencil, and a small hole was blown in the tubing at the spot normally covered by the index finger. An adjustable screw clamp on a short length of rubber tubing attached to the other arm of the Y-tube could be regulated to adjust the degree of suction obtained through the glass "pencil" tube when the pump was operating. The capillary tube was inserted in a hole, made by a heated needle, in the rubber policeman. Suction could then be applied to, or cut off from, the capillary tube by covering, or uncovering, the hole in the glass tubing with the index finger. To fill the capillary tube a wisp of cotton was first drawn into one end, the capillary was reversed in the rubber policeman, and the powdered sample was drawn in and could be tamped down with a glass fibre. In this laboratory the wisp of cotton normally is removed and the ends of the tube may then be sealed in a flame or closed with soft wax or plasticine. Samples may be picked up from an oven, or from an atmosphere of known relative humidity in a desiccator, and then sealed immediately to prevent acquisition of moisture. Efflorescent hydrates or other substances may be crystallized rapidly with constant stirring to ensure small particle size, and then drawn up into the capillary tube together with excess solvent. This capillary-tube method requires less time than mounting the sample on a glass fibre and usually results in sharper, better resolved, powder patterns. It does require, however, somewhat more material than the minimum that can be handled effectively with a glass-fibre mount.

The photographs for the present investigation were taken with two identical cylindrical cameras (North American Philips Co.) of 114.6 mm. diameter, using Straumanis film mounting. Film shrinkage corrections were calculated, but, since they were always less than $\pm$ 0.25%, they were not applied to the film measurements. The X-ray apparatus was a General Electric XRD-1 unit with an X-ray tube furnished with two beryllium windows and a cobalt target ($\lambda(K_\alpha)$=1.790Å). The radiation was filtered with iron foil. With this equipment the largest measurable value of d (i.e., the "cut-off") is 20Å. Exposure times of 15 to 20 hours were adopted to ensure somewhat overexposed films for reproduction; 5 to 10 hours would have been sufficient for ordinary identification purposes in most cases. The negatives were not intensified.

The photographs were measured with a standard powder-film measuring device (North American Philips Co.) having a vernier reading to 0.05 mm. Film measurements (in mm.) were converted to θ values (1 mm. on the film corresponds to 2θ=1°) and the interplanar spacings (d) were then read from tables (13). All films were measured at least twice and individual lines for which significant differences in d values occurred were remeasured; otherwise the average of the two measurements was adopted.

Intensities relative to the strongest line of each pattern (I/I_1) were estimated visually on a scale of 100. Doubtful, or exceedingly faint, lines ($I/I_1<1$) were omitted on the grounds that it is less confusing for such lines not to be included in tabulated data even if real than

[2] Where this cement is not available, a laboratory adhesive the composition of which is given in the *Handbook of Chemistry and Physics* (5), probably would be equally satisfactory.

[3] A standard wire gauge is convenient for testing the outside diameter, and a copper wire of suitable gauge for the bore.

it is to report them when they may be spurious. Owing to the rapid decrease in intensity with increasing values of 2θ, only lines corresponding to $2\theta \leqq 90°$ were measured in most cases.

Results

The tabulated d and I/I_1 data are given at the end of this paper preceded by an *Alphabetical Index*, an "*Innermost Line*" *Index*, and a *Numerical* (*Hanawalt*) *Index*, and followed by reproductions of the diffraction photographs. Each pattern has been assigned a number (1 to 83, inclusive) according to the sequence in the *Alphabetical Index;* these numbers precede the names of the substances in the *Tabulated* (d, I/I_1) *Data* and follow them in the "*Innermost Line*" *Index* and in the *Numerical Index*. They are identical with the numbers of the figures from fig. 1 to fig. 83, inclusive; figs. 84 to 90 illustrate special points arising from the *Notes on Individual Narcotics* (see next section).

For the figures, the powder photographs have been trimmed to 1 in. × 4½ in. symmetrically about the hole whose centre corresponds approximately to $2\theta=0°$, in order to conserve space and because, for the narcotics, the lines generally become very faint or are not observable beyond the length chosen; the outer edges of the patterns correspond approximately to d = 1.89Å Some loss of detail is inevitable because they must be viewed by reflected light instead of by transmitted light as for the original negatives, and because they have passed through several reproduction processes, *viz.*, a contact print on film, a contact print on paper from this intermediate negative, and the steps required to transform the paper print through the "cut" for printing to the final reproduction. This ensures, however, that each figure will have the same appearance (dark diffraction arcs on a light background) as the original X-ray diffraction photograph and the result is not only more "natural" in appearance but makes direct comparison with an original negative much more satisfactory.

Notes on individual narcotics

Codeine (anhydrous free base), Codeine Monohydrate (free base), and Dihydrocodeinone (free base).

The sample of codeine (free base), as received, gave a powder pattern (fig. 84) consisting of a mixed set of smooth and grainy diffraction lines. Examination under the stereoscopic microscope revealed the presence of small prisms, some completely and some only partially opaque, in a mass of finely-divided material. Individual opaque prisms, without crushing, gave excellent powder photographs with smooth lines while those that were partially transparent yielded patterns comprising spots characteristic of single crystals together with lines characteristic of powdered materials, but the single-crystal spots did not appear to originate with the same crystalline phase as that responsible for the powder lines. A portion of the original sample, therefore, was recrystallized from absolute alcohol and another portion from distilled water. In each case the crystals were mechanically ground and powder photographs were taken. The pattern given by the crystals from absolute alcohol (fig. 8) was identical with the set of smooth lines in the original photograph (fig. 84); that given by the crystals from water (fig. 9) was identical with the set of grainy lines. A single-crystal study by X-ray diffraction methods, and comparison with existing crystallographic data (11), enabled the crystals from absolute alcohol to be identified as the anhydrous base and those from water as the monohydrate.

Crystals of codeine monohydrate are efflorescent. The sample examined must originally have contained a large number of prismatic crystals of the monohydrate, many of which had lost their water of crystallization by the time the diffraction photographs were taken. This feature should be borne in mind in cases involving the identification of codeine.

In view of the similarity of the patterns for codeine (anhydrous free base) (fig. 8) and for dihydrocodeinone (free base) (fig. 17), a single-crystal examination of the latter also was carried out. From the shape, dimensions, and symmetry of the unit cell determined by such a study, the spacings of all sets of planes that could give rise to observable powder diffraction lines may be calculated; they can then be compared with the spacings of those lines actually observed. All possible lines may not be represented in the powder pattern because their relative intensity may be too low, but, providing the sample consists of a single crystalline phase, no lines should appear on the powder photograph that correspond to spacings not predicted on the basis of the unit cell data for that phase. It is obviously desirable that all powder patterns should be authenticated from single-crystal data. In practice, however, it is frequently difficult to grow suitable crystals, and, in any event, the establishment of the unit cell constants for a large number of substances for purposes of routine checking of their powder patterns can be very time-consuming.

It should be noted, however, that the present spacings for codeine (anhydrous free base), codeine monohydrate (free base), and dihydrocodeinone (free base) have been verified from single-crystal data for values of d from the maximum observed (which also is the maximum possible) to approximately 3.00Å. The data for codeine (anhydrous free base) are in very good agreement with the measurements of Gross and Oberst (4).

Codeine Phosphate

Codeine phosphate hydrates have been reported (7, 12) with 1, 1½, and 2 moles water per mole anhydrous salt, and the higher ones, at least, are said to be efflorescent. Samples of codeine phosphate from three different commercial sources (A, B, C) were examined. The patterns obtained from A and B when first received are shown

in figs. 85 and 86, respectively; that from C was identical with that from B. The importance of the water content had not become apparent at the time when the first pattern of A was obtained, but C contained 0.75 mole water when received. After seventeen months, the pattern from A exhibited marked differences from the original (at this time the water content was determined as 1.4 mole), and further minor alterations were observed after a further period of three months. It was not possible to investigate possible changes in the original patterns of B and C over such an extended length of time, but that from B after three months was virtually identical with the initial one.

Two reproducible patterns, however, were obtained from both A and B, (a) by heating either sample in an oven at 70°C, and (b) by recrystallizing either sample from distilled water. These patterns constitute figs. 10 and 11, respectively. Furthermore, the phase responsible for the pattern of fig. 10 could be transformed into that giving fig. 11 by recrystallization of the "dried" sample from water and this, in turn, could be reconverted to the original phase (fig. 10) by heating the "wet" sample in an oven at 70°C.

No change in the pattern of the dried material (fig. 10) was observed even after seven days at 60°C followed by two days at 70°C. A water determination by Mrs. P. M. Oestreicher on the dried material showed that it was anhydrous.

The phase recrystallized from water is highly efflorescent. This was demonstrated by patterns obtained from freshly crystallized material (A and B) when precautions were not taken to ensure the presence of excess water with the specimens. It was difficult, therefore, to obtain a reliable estimate of crystal-water and it is assumed, therefore, that fig. 11 represents the pattern of the fully hydrated phase, namely, the dihydrate.

As a guide towards the identification of codeine phosphate, tabulated data ($d > 3.00$Å) for some of the patterns obtained from mixtures intermediate between the anhydrous salt and the dihydrate are given in the accompanying Table of *Patterns of Mixtures of Codeine Phosphate Hydrates*. Detailed analysis of these data indicates that there probably are several hydrate phases involved. The dihydrate appears to be one of the constituents of sample A (as originally received) and also seventeen months later; it is the principal (but not the sole) constituent of samples A and B recrystallized from water without adequate precautions against efflorescence. On the other hand the pattern of samples B and C (as originally received) represents a principal phase that has not been identified. The anhydrous salt may be present in this pattern and in the later one from sample A. Attempts to disentangle the composite patterns represented in the Table, however, are not likely to be successful without detailed knowledge of the possible phases. It is apparent that the codeine phosphate-water system requires a systematic phase rule investigation.

Patterns (for d>3.00Å) of Mixtures of Codeine Phosphate Hydrates

Sample A						*Sample B*			
Original		*After 17 mos.*		*Incomplete hydration*		*Original*		*Incomplete hydration*	
d	*I/I₁*	*d*	*I/I₁*	*d*	*I/I₁*	*d*	*I/I₁*	*d*	*I/I₁*
16.4	40	16.3	35	16.5	50	16.5	40	16.6	35
8.02	25	7.91	30	7.89	35	7.77	50	7.92	35
7.02	5	7.15	15B	7.06	5B	7.24	100	7.06	5B
6.61	100	6.59	100	6.61	100	6.73	20	6.57	100
6.06	15	6.35	55	6.09	20	6.55	40	6.07	10
5.81	10	6.08	8	5.81	25	6.36	75	5.84	45
5.48	30	5.78	70	5.46	45	6.07	1	5.48	35
5.12	35	5.46	20	5.25	10	5.83	75	5.24	30
4.83	15	5.12	45	5.06	45	5.70	30	5.04	45
4.52	60	4.85	10	4.82	40	5.61	30	4.82	45
4.20	60	4.51	50	4.50	45	5.40	40	4.52	40
3.99	75	4.19	20B	4.37	10	5.07	12	4.39	40
3.88	1	3.97	70	4.20	50B	4.79	15	4.21	50B
3.58	75	3.86	40B	4.08	2	4.64	60	4.09	5
3.44	15B	3.57	90	3.98	60	4.42	15	3.98	45
3.27	20	3.42	70	3.89	2	4.32	40	3.89	2
3.16	3	3.28	5	3.57	60	4.19	40	3.74	1
3.08	20	3.16	5	3.50	30	4.10	5	3.57	45
3.02	5	3.04	5B	3.41	25	4.00	15	3.51	45
				3.28	15	3.92	100	3.44	20
				3.22	5	3.72	5	3.29	3
				3.16	8	3.65	60	3.21	6
				3.09	5	3.57	5	3.17	1
				3.01	40	3.42	60	3.09	2
						3.36	60	3.02	35
						3.29	1		
						3.22	40		
						3.17	40		
						3.11	40		
						3.05	8		

Experience with codeine phosphate patterns suggests that, if the powder photograph of an "unknown", by comparison with the tabulated data for the anhydrous salt (no. 10) or the dihydrate (no. 11), or with the data in the Table of *Patterns of Mixtures of Codeine Phosphate Hydrates*, indicates the possible presence of codeine phosphate, a portion of the sample should be placed in an oven at 70°C for at least 24 hours, and then taken up directly from the oven in a capillary tube the ends of which should be sealed immediately, preferably in a flame. If the "unknown" is codeine phosphate the pattern from this specimen will be that of fig. 10. Alternatively, a portion of the sample may be dissolved in distilled water, heated gently (at 60°C to 70°C) until, after removal from the source of heat, crystallization commences before the temperature falls to that of the room. The mixture should be stirred vigorously and the crystals crushed against the side of the vessel as crystallization proceeds in order to ensure small particle size. When the creamy mixture is at room temperature it should be drawn into a capillary tube, care being taken that excess water is present, and the tube should be sealed immediately with vacuum wax. The powder pattern from this material (the dihydrate) will be that of fig. 11 if the "unknown" is, in fact, codeine phosphate.

Conversion to the anhydrous form rather than to the dihydrate is recommended because of the rapid

efflorescence of the latter unless proper precautions are taken. Once obtained, the anhydrous form does not absorb moisture from the atmosphere very rapidly so that ample time, without special care, is available for preparation of the specimen for the powder camera. For example, the typical "anhydrous" pattern was given by two specimens of codeine phosphate (sample B) taken from an oven after one and two days, respectively, at 70°C and exposed to the air of the laboratory for 15 minutes (room temperature, 25.5°C; relative humidity, 48 per cent) and 30 minutes (room temperature, 26°C; relative humidity, 49 per cent), respectively. In both cases, the capillary tubes were flame-sealed after the specimens were introduced. In another test no change in the "anhydrous" pattern was observed after a sample was first converted to the anhydrous phase in an oven at 70°C and then was stored for almost 3 days in an atmosphere of controlled relative humidity, 32.3 per cent, in a desiccator above a saturated solution of $CaCl_2.6H_20$, in contact with the solid, at 20°C.

Cotarnine (free base)

Two different commercial preparations were investigated; the first (A) was dull brick-red in colour, the second (B) was pale yellow. Both samples gave the same pattern (fig. 12) when received, but two powder photographs of A taken seventeen months after the original one showed two additional faint lines, d = 10.3Å, I/I_1 = 3 and d = 8.4Å, I/I_1 = 2, which, however, did not appear on powder photographs of B after a lapse of two months. Small portions of both samples were dissolved in distilled water and allowed to recrystallize at room temperature. In both cases the crystals (with excess water) were taken up in capillary tubes which then were sealed. The diffraction patterns from both specimens (including that from A whose pattern had developed the two "extra" lines) were identical with the original one (fig. 12). It is possible that the two unidentified lines may have been the strongest ones of the pattern of a trace of some product derived from cotarnine at room temperature by a slow rate of loss of the elements of water but from which cotarnine may be reconstituted by recrystallization from aqueous solution. They may, of course, merely have been due to a small quantity of an impurity which was detected only in one specimen.

On heating the dark-coloured sample (A) in an oven at 70°C for twenty-seven hours, its colour altered through a very dark red to a deep purple. A powder photograph of the material at this stage showed only a single broad halo at $2\theta \simeq 25°$, indicating an amorphous product. Therefore, a portion of the pale yellow preparation (B) was placed in an oven at 70°C and samples were removed for powder photographs (in sealed capillary tubes) at the end of 6 hours, 3 days, and 5 days, respectively. At the end of three days, the colour had passed through dark yellow to the dull brick-red shade characteristic of the original sample A; beyond this time further colour changes were similar to those observed for A. The three successive powder patterns showed a progressive weakening and broadening of the diffraction lines with a gradual increase in the intensity of the general background of the film and the emergence of the broad halo at $2\theta \simeq 25°$. At the end of five days only the eight strongest lines of the original pattern (fig. 12) appeared (with greatly diminished intensity) in the powder photograph, together with two or three extremely faint lines of doubtful validity not attributable to cotarnine. The colour changes that cotarnine undergoes at 70°C thus appear to be due to thermal decomposition into an amorphous product, and the difference in colour of the two original samples indicates that such decomposition may occur slowly even at room temperature. Since the two lines that appeared in the photographs of sample A after seventeen months at room temperature were not observed in the photographs of sample B at successive stages of heating at 70°C, two types of decomposition or change may be involved.

No difficulty, however, need be anticipated in the identification of cotarnine providing the possible presence of very faint extraneous lines due to ageing are borne in mind; such lines, in fact, probably would not be observable in a normal exposure time. The thermal decomposition products, which appear to be responsible for the colour of cotarnine samples, add no diffraction lines of any significance to the photographs and the principal lines due to cotarnine are identifiable until decomposition has reached a very advanced stage and the colour of the sample has become very dark.

o-Diphenoloxymorphine (free base)

The only sample of this morphine derivative available for the present investigation gave a pattern consisting of a single, broad, diffuse halo characteristic of an amorphous material. No data, therefore, suitable for identification purposes were obtained.

Diamorphine (free base), Diamorphine Hydrochloride Monohydrate, Morphine Monohydrate (free base), Morphine Hydrochloride (anhydrous), and Morphine Hydrochloride Trihydrate

Gross and Oberst (4) state that "a single pattern is acceptable identification when exact coincidence with a reference is obtained, but the use of two patterns of an alkaloid (one of the base and one of its hydrochloride salt) renders the result conclusive". This appears to reflect the convention usual in most schemes of inorganic qualitative chemical analysis of conducting a confirmatory test for each ion identified. The X-ray diffraction powder method, however, is essentially of the "fingerprint" type because the chance of exact coincidence of the patterns from two different crystalline phases, particularly among organic compounds, is insignificant, except in the special case of *d*- and *l*-anti-

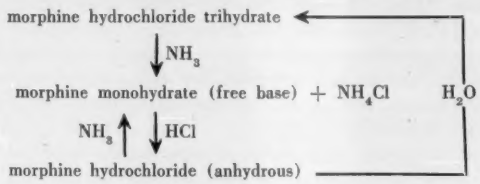
podes. Furthermore, the use of two patterns really serves to double the work of identification because each must be identified separately.

The procedure suggested for obtaining the confirmatory pattern also is open to serious objections. According to Gross and Oberst (4), "Such reactions are readily carried out topochemically as follows: After a pattern of the free base is obtained, the mounted sample may be exposed to hydrochloric acid fumes for a short time. This converts the base to the hydrochloride salt (as shown by the absence of the diffraction lines of the base), and the second diffraction pattern may be obtained. If the starting material were the hydrochloride, exposure to ammonia fumes will convert it to the free base". In the first place, the "absence of the diffraction lines of the base" merely indicates that the base is no longer present in sufficient quantity for its pattern to be registered in the time required to record that of the new constituent; it gives no information about either the original base or the new substance. In the second place, the proposed reactions do not always proceed in the simple manner assumed, as shown by tests carried out on morphine (free base, and hydrochloride) and on diamorphine (heroin) (free base, and hydrochloride).

Experiments were performed (*a*) with mounted specimens (glass fibres and Household Cement) suspended from the stoppers of vials containing a drop or two of concentrated hydrochloric acid or concentrated ammonia solution, and (*b*) with the specimen in one well of a two-well microscope slide and a drop of the reagent in the other, the slide being enclosed in a covered Petri dish. Starting with morphine hydrochloride trihydrate (the usual form of the commercial preparation), exposure to NH_3 fumes for two or three minutes caused partial conversion to morphine monohydrate (free base) with the formation of NH_4Cl; transformation to the free base was complete in less than 30 minutes.

Similar treatment of the free base (monohydrate), either in the form of a fresh commercial sample or prepared (as above) from the hydrochloride, with fumes from concentrated HCl solution, however, gave a product the pattern of which (fig. 47) was *not* that of morphine hydrochloride trihydrate (fig. 48). This pattern was again obtained when the product was dissolved in concentrated hydrochloric acid and the solution allowed to evaporate to dryness. That the new substance was either anhydrous morphine hydrochloride or a lower hydrate became evident (*a*) when it was recrystallized from distilled water and then gave the pattern of the trihydrate and (*b*) when it gave the pattern of morphine monohydrate (free base) (together with that of NH_4Cl) when exposed to the fumes of concentrated NH_3 solution. The same substance (morphine hydrochloride, anhydrous or lower hydrate), as shown by its diffraction pattern, was obtained on treatment of morphine monohydrate (free base) with dry HCl gas; a water determination carried out by Mrs. P. M. Oestreicher established it as the anhydrous form.

The foregoing results may be summarized as follows:



Attempts to obtain anhydrous morphine hydrochloride by storage of the trihydrate in a desiccator under vacuum and by heating in an oven at 50°C gave substances whose patterns did not correspond with that of anhydrous morphine hydrochloride, although a loss of three moles of water occurred.

The results obtained when diamorphine (heroin) (free base) and diamorphine hydrochloride monohydrate were subjected to concentrated HCl fumes and to NH_3 fumes, respectively, were entirely different from those of the corresponding tests with morphine. The diamorphine (free base) exposed to HCl fumes in a closed Petri dish gave a pattern that was not that of diamorphine hydrochloride monohydrate and which underwent no change when the product was recrystallized from distilled water, thus indicating that it was not simply anhydrous diamorphine hydrochloride. Further exposure of the same sample to HCl fumes in a closed vial finally gave a product from which the pattern of anhydrous *morphine* hydrochloride was obtained together with a few faint lines due to some other substance, thus showing that continued exposure of diamorphine to HCl leads to deacetylation.

Prolonged exposure of diamorphine hydrochloride monohydrate to NH_3 fumes at first resulted in no change in pattern (other than the appearance of lines due to NH_4Cl) and finally in the emergence of additional lines not attributable to the presence of the free base.

These vapour treatments, therefore, cannot be recommended as general aids to the identification either of the free bases or of their hydrochloride salts.

The present powder diffraction data are in good agreement with those of Gross and Oberst (4) for morphine monohydrate (free base) but not for morphine hydrochloride. It is possible that their sample of the latter was a mixture of the trihydrate and the anhydrous salt. Agreement is very poor also for both diamorphine (heroin, diacetylmorphine) (free base) and for diamorphine hydrochloride monohydrate.

Dihydromorphinone (free base) and Dihydromorphinone Hydrochloride

No difficulty was experienced in obtaining duplicate patterns from two commercial preparations of dihydromorphinone (dilaudid) hydrochloride. Although recognizable as probably the same as that observed by Gross and Oberst (4) there are many discrepancies between the measured values for corresponding interplanar spacings.

No data for dihydromorphinone (free base) are included in the present paper. Several laboratory specimens prepared by Dr. C. G. Farmilo from the hydrochloride by the action of ammonia were investigated. The diffraction patterns of the products, however, showed so many variations that it became obvious that a separate study of the free base should be undertaken. Some of the patterns undoubtedly represent pure substances; others certainly are due to mixtures. One showed some superficial resemblance to the data given by Gross and Oberst (4). Some indication was obtained that the product may depend on the pH of the solution resulting from the addition of ammonia to the aqueous solution of the hydrochloride. It is suspected also that keto-enol tautomerism may be involved.

Mescaline Sulphate Dihydrate

The present data are in very good agreement with those for mescaline sulphate in the A.S.T.M. Index (1). The latter were obtained from patterns given by copper radiation and with an apparatus "cut-off" of 9.3Å; the strongest line (d = 6.72Å), therefore, also is the "innermost" line, whereas the present pattern extends the data to d = 19.6Å. In spite of the different wavelengths employed, the order of the strongest lines is virtually the same; 6.72, 4.82, 3.61, 3.46, 3.28Å, each with I/I_1 = 100 as recorded on the A.S.T.M. card (no. 4-0157); 6.72, 4.81, 3.29, 3.96, 3.60Å, with I/I_1 = 100, 90, 85, 80, 80, respectively, for the present pattern, thus resulting only in a different allocation of the "third" line.

dl-Methadone Hydrobromide and dl-Methadone Hydrochloride

The present data for *dl*-methadone hydrochloride are in very good agreement with those obtained by Hubach and Jones (8) for a sample from a different commercial source. With copper radiation the spacings of the three strongest lines of their pattern are 7.46Å (v.v.s.), 4.55Å (v.v.s), 6.45Å (v.s.); with cobalt radiation the spacings of the three strongest lines of the present pattern are 4.56Å (100), 7.49Å (90), 6.47Å (60), thus merely interchanging the "first" and "second" lines.

The patterns and numerical data for *dl*-methadone hydrobromide (fig. 35) are strikingly similar to those for *dl*-methadone hydrochloride (fig. 37). Although single-crystal data have not yet been obtained, it is probable that the two salts are isomorphous and have unit cells of comparable dimensions. If so, then, relative to the size of the methadone molecule itself, the substitution of Cl for Br should have only a small effect on the spatial requirement of the methadone hydrohalide molecule, and hence the interplanar spacings, and relative reflection intensities, of corresponding sets of planes in the two structures should be very similar.

In the case of isomorphous NH_4Cl and NH_4Br the effect of the halide ion on the unit cell dimensions, and thus on the observed values of d, is much more pronounced because the radius of the ammonium ion actually is smaller than that of either halide ion and the diffraction patterns of the two salts are readily distinguishable. They form, however, mixed crystals (crystalline solid solutions) the interplanar spacings of which have values intermediate between the corresponding ones of the pure ammonium halides depending on the relative atomic proportions of each halogen.

Since the ammonium halides can often be identified more readily than the hydrohalide salt of a large organic molecule, it is sometimes convenient to convert the latter to the free base and the ammonium salt by treatment with ammonia, and then to identify the ammonium halide. This can be done very rapidly by dissolving the organic salt in distilled water, adding a slight excess of concentrated NH_3 solution, and gently evaporating the solution to dryness. The method of Gross and Oberst (4) of exposing the mounted sample to NH_3 fumes also is very convenient for this purpose when interest is centered on the ammonium salt rather than on the organic base. A rapid (½ hour) exposure with copper radiation usually is sufficient to record the strongest lines of the ammonium halide pattern, and these are sufficient to decide between the bromide and the chloride.

One commercial preparation (A) of *dl*-methadone hydrochloride and two laboratory preparations (B,C) of the corresponding hydrobromide were examined. Of the latter, the second (C) was prepared by Dr. C. G. Farmilo from the hydrochloride (sample A) by precipitation of the free base and complete removal of ammonium chloride, as indicated by silver nitrate tests of the effluent wash water. The free base was then converted to the hydrobromide by treatment with hydrobromic acid (analytical reagent grade).

Identical patterns were obtained from two specimens of the hydrochloride (A) and for a (powdered) single crystal obtained by recrystallization from distilled water. Measurements of the pattern of the ammonium salt released by the action of NH_3 on a specimen of the hydrochloride were in excellent agreement with the precision data of Havinghurst, Mack and Blake (6) for NH_4Cl.

Identical patterns also were obtained from specimens of the pure hydrobromide (C) as received and after recrystallization from distilled water. The pattern for the ammonium salt released by the action of NH_3 also was in excellent agreement with the data of Havinghurst, Mack and Blake (6) for NH_4Br.

In the case of the hydrobromide sample B, however, although the patterns obtained from two specimens selected at random from the original container were virtually identical with that from sample C, specimens prepared by crushing (*a*) several crystals, (*b*) two individual crystals, (*c*) one crystal, obtained by recrystallization from water, gave patterns of increasing resemblance to that from the hydrochloride. In each case the patterns of the ammonium salts were obtained and

measured. The results for the interplanar spacings are shown in the accompanying table of *Comparison of Interplanar Spacings of Ammonium Halides Obtained from Samples A,B,C with those of NH_4Cl and NH_4Br.*

The data in columns 5 and 6 are from short-exposure films and are, therefore, not as complete as those in the other columns because only the lines of higher relative intensity were sufficiently strong for accurate measurement.

Comparison of Interplanar Spacings of Ammonium Halides Obtained from Samples A, B, C with those of NH_4Cl and NH_4Br

			B (recrystallized from water)				
$NH_4Br(6)$	C	B	composite	2 crystals	1 crystal	A	$NH_4Cl(6)$
4.05	4.04	4.02	4.00	3.94	3.92	3.86	3.87
2.86	2.85	2.84	2.83	2.78	2.76	3.74	3.73
2.34	2.34	2.32	2.31	2.28		2.23	2.23
2.02	2.02	2.01	2.00	1.97	1.96	1.94	1.93
1.81	1.81	1.80	1.79	1.76	1.73	1.73	1.73
1.65	1.65	1.64	1.63	1.61	1.60	1.58	1.58
1.43	1.43	1.42	1.42			1.37	1.37
1.35	1.35	1.34	1.34			1.29	1.29
1.28	1.28	1.27	1.27			1.22	1.22
1.22	1.22	1.21	1.21			1.17	1.17
1.17	1.17	1.16	1.16			1.12	1.12
1.12	1.12	1.12	1.11			1.07	1.07
1.08	1.08	1.08	1.07			1.04	1.03

From the data for the ammonium salts it is apparent that sample B, although largely the hydrobromide, does contain some of the hydrochloride. The evidence also suggests the presence of mixed crystals, methadone-H(Br,Cl), since the patterns from the various specimens prepared from sample B appear to be intermediate between those of the pure hydrobromide (sample C) and the pure hydrochloride (sample A), rather than mixtures of the two. Furthermore, the crushed single crystal not only gave the pattern most closely approaching that of pure *dl*-methadone hydrochloride but that of the corresponding ammonium salt (see table, column 6) most closely approaches that of NH_4Cl. It should be pointed out, however, that the ammonium salt obtained by the addition of ammonia to a mixture of the hydrochloride and the hydrobromide would itself be a solid solution, $NH_4(Br,Cl)$, regardless of whether the original material consisted of a mixture of pure hydrochloride and pure hydrobromide crystals or whether it was composed of mixed hydro-(bromide, chloride) crystals.

In cases of possible ambiguity due to suspected isomorphism, or mixed crystal formation, among the hydrohalide salts of a narcotic base, it is convenient in the first place simply to identify the narcotic as the hydrohalide salt, and then to liberate the ammonium halide and identify the halogen in a subsequent step.

Parenthetically, attention may be drawn to the fact that while the pattern of *dl*-methadone hydrochloride (fig. 37) is not the same as that of the *d*- (and *l*-) antipode (fig. 36), the patterns of the free base in the *d*-, *l*-, and *dl*-forms are identical (fig. 34).

Metopon (free base) and Metopon Hydrochloride

The present interplanar spacings for metopon hydrochloride are in good agreement with those given by Gross and Oberst (4).

Metopon (free base), however, was somewhat troublesome. The first pattern (fig. 87) was obtained from a mechanically ground specimen and was not entirely satisfactory because several of the lines were unusually broad. A second pattern from another specimen of the same sample, but in a capillary tube and not ground, was normal in appearance (see fig. 43) but a few moderately strong lines in the original pattern were missing and there was a marked difference in the relative intensities of other lines. A third pattern, however, was identical with the second. The time intervals between patterns were approximately four months between the first and second, and two weeks between the second and the third. Since the water content corresponded to 1.8 moles it was suspected that a mixture of dihydrate and a lower hydrate, or the anhydrous base, might be involved. Accordingly, the last remaining portion of the original sample (not more than 0.1 mg.) was kept at 70°C in an oven for four days, after which it was taken up in a capillary tube which was then sealed with wax. A pattern identical with the second and third was obtained. Since there was insufficient material to recrystallize from water, the capillary tube was opened, distilled water was introduced, and it was resealed with wax. The "wet" specimen gave the same pattern as the dry. The specimen was pushed out of the capillary tube with a glass fibre and divided into two portions. Both were crushed separately and were mounted on separate glass fibres with Household Cement; one specimen was intentionally subjected to more vigorous grinding. The resulting patterns closely resembled the original one (fig. 87); that from the more vigorously ground specimen being virtually identical with it. The specimens were so small that better resolution of the diffraction lines was obtained and it became obvious that the breadth of some of the lines in the original pattern (fig. 87) was due simply to unresolved pairs of lines. Mechanical grinding of metopon (free base), therefore, apparently causes some alteration in the substance, probably a polymorphic transformation.

Numerical data for the suspected polymorph are not included in the present paper because it is not certain that complete transformation was achieved. Sufficient material was not available for more exhaustive tests but it seems desirable to avoid mechanical grinding of any "unknown" suspected to be metopon (free base).

Morphine Sulphate

Two commercial preparations (A,B) were examined. The patterns from each varied between that for the pentahydrate (fig. 52) and that for the dihydrate (fig. 51), the intermediate ones (e.g., fig. 88) representing mixtures of the two phases, depending on conditions of temperature and relative humidity. The original samples

gave the pentahydrate pattern and no change of the material in the stoppered bottles was observed over a period of fifteen months providing the specimens for X-ray diffraction photographs were taken up in capillary tubes without grinding. Crushing the samples, or merely spreading them on a microscope slide and exposing them to the air of the room, sometimes resulted in partial or complete change of the pentahydrate to the dihydrate or *vice versa*, depending on the relative humidity prevailing in the laboratory. Thus, during a period of high temperature and low humidity a sample of the pentahydrate changed to the dihydrate overnight whereas no transformation of another specimen of the pentahydrate occurred after six days at a time when the relative humidity was much higher. Controlled relative humidities (at 20°C of 32.3 per cent and 20 per cent, respectively), had no effect on the pentahydrate over periods of several days. In the presence of anhydrous $CaCl_2$ a partial transformation of the pentahydrate to the dihydrate was observed but anomalous results were obtained in a P_2O_5 desiccator (*i.e.*, from no detectable change to almost complete conversion to the dihydrate with different specimens).

The dihydrate remained unchanged after storage for a week over P_2O_5. It was, however, converted into the pentahydrate in less than 30 minutes when exposed to the air of the laboratory at a temperature of 21°C and a relative humidity of 50 per cent.

The pentahydrate can always be assured by the addition of a trace of water to the capillary tube containing the sample, and the dihydrate can always be obtained from the pentahydrate by heating for a few hours (conveniently overnight) at 60°C or 70°C. No change in the observed patterns of specimens of the dihydrate occurred after they had been kept continuously in an oven at 70°C for as long as six weeks.

If the pattern of an "unknown" appears to be a mixture of morphine sulphate dihydrate and morphine sulphate pentahydrate, it is recommended that the specimen be converted fully into one or the other for final identification. In either case the sealed capillary-tube method should be used.

The present data for morphine sulphate dihydrate and for morphine sulphate pentahydrate are in reasonably good agreement with the measurements of Gross and Oberst (4), although it is probable that their 3.84Å spacing for the dihydrate corresponds to that of 3.93Å in the present pattern because the relative intensity of the latter is much higher than that of the line representing d = 3.85Å. The absence of the 6.50Å line (I/I_1 = 60) from the data of Gross and Oberst for the pentahydrate apparently is due to its non-resolution from the 6.21Å line (*cf.*, their fig. 2). Finally, the presence of the 7.16Å line (the second strongest of the dihydrate pattern) in their data for the pentahydrate suggests a trace of the dihydrate in the pentahydrate specimen; the strongest line (6.24Å) of the dihydrate would not be resolved from the strongest line (6.21Å) of the pentahydrate on their films.

Narcotine Hydrochloride

Narcotine hydrochloride was particularly troublesome and, like codeine phosphate, warrants a more thorough investigation than was possible during the present survey. It has been reported (7,12) as crystallizing with ½, 1, 3, and 4 moles of H_2O and is known to form basic salts. Two commercial samples (A,B) were examined.

Sample A consisted of very small anhedral crystal fragments. Of seven specimens selected at random over a period of nineteen months, four (including one heated to 64°C for 22 hours) gave identical patterns (fig. 58), the photographs from two showed a very faint additional line, and that from one exhibited a large number of "extra" lines indicating a mixture of the phase giving rise to the original pattern and some other constituent. Crushing the specimens, or heating them at 64°C, had no effect on the patterns. The results, therefore, suggest that sample A is essentially a pure phase, narcotine hydrochloride (I) (fig. 58) with a small proportion of another phase (or other phases), the size of the specimens used for the X-ray diffraction patterns being too small to ensure the same relative proportions of the different constituents in each specimen.

Three specimens of sample B (*a*, ground and mounted with Household Cement on a glass fibre; *b*, heated for 22 hours at 64°C; *c*, taken up in a capillary tube from the original container) gave patterns which, although not identical, were very much alike and were very similar to the complex (mixture) pattern obtained from one specimen of sample A. That from the unground specimen (*c*) consisted of a mixture of smooth and grainy lines, the former corresponding to those of the narcotine hydrochloride (I) pattern of sample A. The larger crystal fragments responsible for the grainy lines could be hand-picked from the sample under a stereoscopic microscope. Several of these were selected and were washed individually with carbon tetrachloride to disengage fine particles adhering to them. Each was crushed to a fine powder and a diffraction pattern was obtained. From the results, two patterns, narcotine hydrochloride (II), (fig. 59) and narcotine hydrochloride (III) (fig. 60), were isolated, and it was found that virtually all the "extra" lines in the complex pattern from one specimen of sample A were due to narcotine hydrochloride (II) while the presence of a trace of narcotine hydrochloride (III) would account for most of the others. One of the crushed specimens giving the narcotine hydrochloride (II) pattern was extruded from its capillary tube and was reground; the resulting pattern showed a few minor changes in relative intensities but no radical differences from the first pattern.

It thus appears that both commercial samples (A, B) represent mixtures of at least three phases. Sample A is essentially narcotine hydrochloride (I) with a small proportion of narcotine hydrochloride (II) and probably a trace of narcotine hydrochloride (III); sample B contains a much larger proportion of narcotine hydrochloride (II) with some narcotine hydrochloride

(III). Detailed comparison of all the patterns indicates that there may be at least one other phase present.

Attempts to identify the phases (probably different hydrates) responsible for the patterns designated narcotine hydrochloride (I), (II), and (III) were not successful. Exposure to air saturated with water vapour and recrystallization from dilute hydrochloride acid produced substances whose patterns could not be correlated with any of those previously obtained. It is clear that a prolonged and detailed study may be necessary. Since the water content of sample A (0.6 mole) was much less than that of sample B (1.17 mole), narcotine hydrochloride (I) presumably is a lower hydrate.

The data for the narcotine hydrochlorides (I, II, III) probably are the least reliable of those presented in the present paper. Those for narcotine hydrochloride (I), although repeatedly obtained, are based on (small) composite specimens of sample A; the pattern, therefore, may contain some weak lines from an unidentified phase, although this is believed to be unlikely. The patterns for narcotine hydrochlorides (II) and (III) should represent pure phases (including, of course, the possibility of mixed crystals) because they were obtained from individual fragments that appeared to be single crystals. Unfortunately it was impossible to remove all adhering particles of powder from their surfaces without breaking them, so that some weak lines may be due to other phases. The mass of the unremovable particles, however, appeared to be negligible compared with that of the crystal fragments, and, as a further precaution, lines in the diffraction patterns having relative intensities $(I/I_1) < 2$ have not been included in the tabulated data.

Although there is a close similarity between the three strongest lines of narcotine hydrochloride (II) and those of narcotine hydrochloride (III), there are too many major differences in the patterns as a whole to leave any doubt that they represent different phases. They may be isomorphous, and mixed crystal formation may be involved.

Pethidine Hydrochloride

The present data for pethidine (demerol) hydrochloride were obtained from two identical patterns given by separate specimens of a single commercial sample. No unusual features or difficulties were encountered with this substance but the observed spacings are in very poor agreement with those given by Gross and Oberst (4).

dl-α-Prodine Hydrochloride and dl-β-Prodine Hydrochloride

One sample each of *dl*-α-prodine hydrochloride and of *dl*-β-prodine hydrochloride were examined. There was reason to assume that both had been prepared and separated by the method of Ziering and Lee (14). Two specimens of the α-form gave identical patterns (fig. 75), as did two specimens from the sample alleged to be the β-form. The latter pattern, however, from an unground specimen, consisted of a set of very grainy lines (identified as due to the α-form) and a set of less grainy lines presumably due to the β-form; the pattern from a ground specimen is shown in fig. 89.

Under the stereoscopic microscope it was possible to separate crystals of two different habits from the much smaller anhedral crystal fragments of which the sample of *dl*-β-prodine hydrochloride largely was composed. Although both monoclinic, the superficial appearance of the larger crystals was that of rectangular plates while that of the smaller ones was of elongated pseudo-hexagonal plates. Single-crystal photographs showed that the two types of crystals represent different structures. Powder photographs of crushed single crystals of both types, washed with amyl acetate to remove adhering fragments, led to the identification of the pseudo-rectangular plates with the original sample of the α-form, and the pseudo-hexagonal plates with the second constitutent of the sample of the β-form.

From the method of separation of the α-form from the β-form (14) it is perhaps not surprising that the latter should contain an appreciable proportion of the former.

Protopine (free base)

The first two diffraction photographs of a commercial sample of protopine indicated a mixture of crystalline phases because the second showed a very few grainy lines in addition to the smooth lines observed in the first pattern. A third specimen (not ground) gave a composite pattern (fig. 90) of smooth and grainy lines. Microscopic examination revealed the presence of clear crystal fragments in a mass of much smaller material. Through the courtesy of Dr. L. Marion, a pure authenticated sample of protopine crystals extracted from *Adlumia fungosa*, and a second commercial sample from the same firm as the original, were obtained. A single-crystal X-ray diffraction study of the former and a powder photograph of the latter demonstrated their identity and showed that, while the grainy lines in the patterns from the original material were due to protopine, the smooth lines were not. From the single-crystal data the protopine powder data were authenticated from the maximum d observed (which is also the maximum possible) to $d = 2.90$Å.

The second constituent of the original sample was not identified. It is unlikely to be a decomposition product because three clear crystals of protopine exhibited no visual microscopic evidence of any change whatsoever after a period of three days in an oven at 70 degrees C. In the absence of any evidence that protopine forms hydrates, it is suspected that the unidentified phase represents another alkaloid not separated from the protopine during isolation of the latter. Information could not be obtained about the source material for the first protopine preparation, otherwise it would have been feasible to obtain patterns of other alkaloids that might be expected to have been isolated with the protopine. The pattern from the "unknown" does not match that of cryptopine or that of any other narcotic included in the present survey.

Thebenine Hydrochloride Monohydrate

Six specimens from a single sample of thebenine hydrochloride monohydrate gave identical patterns (fig. 83), except for a weak (I/I_1 = 3) line corresponding to d = 12.7Å that was present in one of the photographs. This line has been omitted from the tabulated data. It cannot be due to thebaine (free base) (from which thebenine hydrochloride may be prepared (12)) nor to thebaine hydrochloride; it probably represents a trace of some other alkaloid present in such small amount that enough for the appearance of one very weak line was present only in one specimen of the thebenine hydrochloride monohydrate sample examined.

Note Added in Proof (September 1954)

The authentication of the patterns for some of the narcotics (codeine (anhydrous free base), codeine monohydrate (free base), dihydrocodeinone (free base), protopine) on the basis of single-crystal data has been extended to *dl*-methadone hydrobromide, *dl*-methadone hydrochloride, *dl*-alphaprodine hydrochloride, *dl*-betaprodine hydrochloride, papaverine (free base), and papaverine hydrochloride, since this paper was completed in 1953 (see Barnes, W. H. and Forsyth, W. J., Unit Cell, Space Group, and Indexed X-Ray Diffraction Powder Data for Certain Narcotics. I-V., *Can. J. Chem.*, *32*, 984-995, 1954). Furthermore, a Fifth Set of Data Cards, recently issued by the American Society for Testing Materials (1), includes information on *dl*-methadone hydrobromide (Card 5-0128), *dl*-methadone hydrochloride (Card 5-0137), morphine sulphate pentahydrate (Card 5-0179), papaverine hydrochloride (Card 5-0279), and codeine phosphate dihydrate (Card 5-0345), supplied by Eli Lilly and Company, Indianapolis, Indiana, and obtained with Cu radiation. Agreement with the present results for *dl*-methadone hydrobromide, *dl*-methadone hydrochloride, and papaverine hydrochloride is good in so far as d values are concerned, although the Lilly data generally are slightly lower; there are greater differences among the I/I_1 estimations, in part perhaps owing to the different radiation employed. On the appropriate A.S.T.M. cards, λ=1.5374 (kX); for direct comparison with present values, the d's of these cards, therefore, should be increased by almost 0.3% (equivalent to the use of λ=1.5418Å). In the case of papaverine hydrochloride no line of d=8.77 (A.S.T.M. Card 5-0279) should appear according to the single-crystal data.

The present results for morphine sulphate pentahydrate are in only fair agreement with those recorded on A.S.T.M. Card 5-0179. The d values of the latter (calculated with λ=1.5418, according to the card) in general are higher than the corresponding ones obtained in this laboratory, and by Gross and Oberst (4), particularly in the (less accurately measurable) small 2θ region.

There is very poor agreement (both for d and I/I_1) between the two sets of results for codeine phosphate dihydrate. The A.S.T.M. values for d (Card 5-0345) in some cases are higher, and in others lower, than corresponding ones presented in this paper; they resemble more closely the results obtained for Sample B (original) as shown in the Table of *Patterns of Mixtures of Codeine Phosphate Hydrates* (see p. 30) and believed to represent the pattern of a phase that was not identified. The discrepancy serves to illustrate further the difficulties inherent in the identification of codeine phosphate unless suitable precautions are observed.

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Alphabetical Index

The narcotics are listed alphabetically according to "common names" chosen for reasons given in another paper (3), where the corresponding structural formulae, complete chemical names and synonyms also will be found. In arranging the index the prefixes *d-*, *l-*, *dl-*, have been ignored in determining the alphabetical sequence because identical X-ray diffraction powder patterns always are obtained from *d-* and *l-* antipodes and sometimes also from the corresponding *dl*-racemoid. When these prefixes (dextro-, levo-, race- (or racem-)) usually form part of the accepted name of the substance they have been changed to the corresponding letters (*d-*, *l-*, *dl-*). Thus Dextromethorphan, Levomethorphan, Racemethorphan are listed as *d*-Methorphan, *l*-Methorphan, *dl*-Methorphan, respectively, and Dextrorphan, Levorphan, Racemorphan appear as *d*-Orphan, *l*-Orphan, *dl*-Orphan, respectively. (In the case of *l*-Orphan Tartrate Dihydrate a sample of the *d*-form was not available for the present investigation; its pattern, however, would be the same as that obtained from the *l*-antipode, and the data for the latter are listed, therefore, under "*d-*, and *l*-Orphan Tartrate Dihydrate".) The prefixes "alpha" and "beta" have been altered to "α" and "β" and ignored in the alphabetical listing, in order to place Alphaprodine Hydrochloride and Betaprodine Hydrochloride in sequence under "Prodine Hydrochloride" (with the appropriate Greek letter prefix).

To avoid any ambiguity between the alkaloids and their salts, the names of the former are followed by the words *free base* in parentheses. Also, where the pattern for an anhydrous substance has been obtained in addition to that of a hydrate, the word *anhydrous* has been added in parentheses to the name of the alkaloid, and the degree of hydration has been incorporated in the name of the hydrate. Where the name of a non-hydrate occurs without the designation (anhydrous), the anhydrous form is implied except in the case of Papaverine Hydrochloride for which accurate water determinations were not available and in a few cases where the degree of hydration was uncertain.

Following the name of each narcotic in the alphabetical index is a number which corresponds with that of the reproduction of a typical powder photograph of the substance among the Figures. After this number are given in sequence the spacing (*d*) of the first, second and third strongest lines and that of the "innermost line" (*i.e.*, maximum *d* observed), and then the relative intensity (I/I_1) of the first, second and third strongest lines, and that of the "innermost line". Where the relative intensities of two (or three) of the strongest lines are equal, the A.S.T.M. convention (1) has been followed of using the descending order of the *d* values to fix the sequence 1, 2, 3. Thus, of two lines having $I/I_1 = 100$, that with the larger spacing is designated 1 and the other 2. Similarly if more than one line has the same relative intensity that would correspond to position 3 in the list, the line with the largest *d* is chosen.

Finally, the star after a name indicates that further information about that substance will be found in the *Notes on Individual Narcotics*.

		d				I/I_1			
Name	*No.*	*1*	*2*	*3*	*I.I.*	*1*	*2*	*3*	*I.I.*
Acedicon® Hydrochloride	1	10.4	4.81	4.22	11.6	100	80	75	15
Acetoxyketobemidone Hydrochloride	2	5.76	4.90	6.33	11.1	100	90	85	60
Alphaprodine....*See* Prodine									
Apomorphine Hydrochloride	3	8.08	4.40	4.03	11.2	100	90	80	10
Benzylmorphine (free base)	4	7.58	5.80	4.11	8.58	100	100	100	90
Benzylmorphine Hydrochloride	5	9.78	3.63	5.35	9.78	100	90	80	100
Betaprodine....*See* Prodine									
Cocaine (free base)	6	4.41	7.38	9.72	9.72	100	60	50	50
Cocaine Hydrochloride	7	5.88	10.7	3.09	10.7	100	90	75	90
Codeine (anhydrous free base)*	8	6.47	3.77	4.89	10.1	100	75	60	15
Codeine Monohydrate (free base)*	9	4.85	8.76	6.73	8.76	100	90	50	90
Codeine Phosphate (anhydrous)*	10	6.30	3.86	6.74	16.1	100	80	65	20
Codeine Phosphate Dihydrate*	11	6.55	3.51	5.06	17.0	100	60	40	20
Cotarnine (free base)*	12	6.39	3.53	7.05	7.05	100	100	60	60
Cryptopine (free base)	13	5.56	2.83	4.01	7.36	100	80	60	40
Dextromethorphan....*See* Methorphan									
Dextrorphan.... *See* Orphan									
Diamorphine (free base)*	14	5.29	7.00	5.08	10.7	100	75	50	10
Diamorphine Hydrochloride Monohydrate*	15	9.03	5.17	7.26	17.6	100	90	80	10
Dihydrocodeine (free base)	16	6.33	7.10	6.16	9.63	100	80	80	10
Dihydrocodeinone (free base)*	17	6.49	3.78	4.83	10.1	100	75	40	15
Dihydrocodeinone Bitartrate (Dihydrate?)	18	8.44	5.12	4.28	16.6	100	90	80	10
Dihydromorphine Monohydrate (free base)	19	6.01	7.41	4.18	10.1	100	75	60	20
Dihydromorphinone Hydrochloride*	20	6.65	6.06	4.57	9.62	100	100	80	50
Dioxyline Phosphate	21	6.91	3.59	4.24	12.4	100	50	40	30
Ethylmorphine Hydrochloride	22	3.92	8.10	5.69	11.2	100	80	80	20

Alphabetical Index (*continued*)

Name	No.	*d*				I/I_1			
		1	*2*	*3*	*I.I.*	*1*	*2*	*3*	*I.I.*
Ethylnarceine Hydrochloride	23	4.37	6.34	12.6	12.6	100	90	75	75
Ethylpethidine Hydrochloride	24	6.93	13.3	4.46	13.3	100	90	80	90
Hydrastinine Hydrochloride Monohydrate	25	3.46	5.17	8.09	9.50	100	80	60	40
Hydromorphone....*See* Dihydromorphinone									
Hydroxypethidine (free base)	26	4.55	7.50	5.35	14.8	100	75	75	60
Hydroxypethidine Hydrochloride	27	5.00	3.75	5.53	13.9	100	75	70	50
dl-Isomethadone Hydrochloride Monohydrate	28	7.25	5.83	5.28	13.1	100	75	50	15
Ketobemidone (free base)	29	4.49	8.44	5.08	8.77	100	60	40	3
Ketobemidone Hydrochloride	30	5.09	3.67	3.81	9.46	100	75	60	50
dl-Laudanine (free base)	31	6.79	4.30	4.08	9.69	100	60	60	40
Levomethorphan....*See* Methorphan									
Levorphan....*See* Orphan									
Meconic Acid Trihydrate	32	3.24	9.86	2.48	9.86	100	60	50	60
Mescaline Sulphate Dihydrate*	33	6.72	4.81	3.29	19.6	100	90	85	15
d-, *l*-, and *dl*-Methadone (free base)	34	8.36	6.74	4.70	9.41	100	90	75	1
dl-Methadone Hydrobromide*	35	4.60	7.58	6.52	12.6	100	90	80	30
d-, and *l*-Methadone Hydrochloride	36	4.42	7.43	4.73	12.4	100	40	30	15
dl-Methadone Hydrochloride*	37	4.57	7.50	6.48	12.4	100	90	70	25
dl-Methorphan (free base)	38	3.90	6.64	5.14	10.3	100	90	90	20
d-, and *l*-Methorphan Hydrobromide Monohydrate	39	5.20	3.83	5.63	13.7	100	90	60	40
dl-Methorphan Hydrobromide Dihydrate	40	4.65	3.86	6.94	18.3	100	50	40	12
Methylketobemidone (free base)	41	4.28	5.98	7.69	8.56	100	90	80	75
Methylketobemidone Hydrochloride	42	5.82	4.80	3.36	9.63	100	60	60	25
Metopon (Dihydrate?) (free base)*	43	10.1	5.59	9.13	10.1	100	95	75	100
Metopon Hydrochloride*	44	4.22	6.96	6.49	8.28	100	80	80	15
α-Monoacetylmorphine (free base)	45	6.55	4.75	7.07	10.4	100	75	70	25
Morphine Hydriodide Dihydrate	46	3.89	4.72	6.03	11.0	100	70	60	50
Morphine Hydrochloride (anhydrous)*	47	6.79	5.95	4.16	8.12	100	80	60	5
Morphine Hydrochloride Trihydrate*	48	6.11	3.95	10.4	11.1	100	100	85	1
Morphine Monohydrate (free base)*	49	5.98	7.42	6.61	10.1	100	60	60	30
Morphine-N-oxide (free base)	50	5.71	5.18	3.72	9.73	100	50	50	3
Morphine Sulphate Dihydrate*	51	6.26	7.18	4.28	14.3	100	40	40	15
Morphine Sulphate Pentahydrate*	52	6.20	4.37	3.68	15.0	100	90	80	70
Morphine Tartrate Monohydrate	53	5.35	4.68	7.79	15.3	100	50	40	15
Morphothebaine Hydrochloride	54	10.6	3.75	3.54	10.6	100	100	100	100
Nalorphine Hydrochloride	55	5.06	7.33	6.91	10.5	100	80	80	20
Narceine (free base)	56	13.8	4.14	5.08	13.8	100	50	45	100
Narcotine (free base)	57	3.49	7.64	6.22	16.2	100	75	50	25
Narcotine Hydrochloride (I)*	58	6.40	4.23	7.97	14.8	100	80	75	30
Narcotine Hydrochloride (II)*	59	8.18	6.76	10.6	15.9	100	90	75	30
Narcotine Hydrochloride (III)*	60	6.77	8.16	11.6	16.4	100	65	60	25
Neopine Hydrobromide	61	6.04	4.20	5.64	12.2	100	90	80	40
Opianic Acid	62	7.39	11.1	3.39	11.1	100	60	60	60
dl-Orphan (free base)	63	5.84	4.15	6.22	8.28	100	75	60	40
dl-Orphan Hydrobromide	64	5.53	3.94	3.31	14.7	100	90	75	20
d-, and *l*-Orphan Tartrate Dihydrate	65	8.23	4.13	5.69	9.39	100	75	50	3
Oxycodone (free base)	66	5.88	5.21	7.70	10.5	100	50	40	20
Oxycodone Hydrochloride	67	10.6	7.28	5.44	11.6	100	90	75	2
Papaverine (free base)	68	5.79	3.73	3.87	14.8	100	90	85	10
Papaverine Hydrochloride	69	4.56	5.12	3.57	10.1	100	75	75	20
Pethidine (free base)	70	9.49	5.46	4.79	9.49	100	80	60	100
Pethidine Hydrochloride*	71	8.04	3.61	4.67	8.04	100	90	75	100
Phenadoxone (free base)	72	6.20	4.50	7.62	8.79	100	90	45	25
Phenadoxone Hydrochloride	73	6.39	5.20	3.84	12.8	100	100	90	30
Pipidone Hydrochloride	74	7.08	4.94	4.19	10.8	100	80	50	40
dl-α-Prodine Hydrochloride*	75	7.14	5.96	6.69	15.1	100	80	70	50
dl-β-Prodine Hydrochloride*	76	8.13	5.87	5.10	11.2	100	70	70	20
Propylketobemidone (free base)	77	10.6	5.02	5.77	10.6	100	90	50	100
Protopine (free base)*	78	4.47	5.96	4.36	10.7	100	90	80	20
Pseudomorphine Trihydrate (free base)	79	6.54	8.76	4.44	9.23	100	75	75	30
Racemethorphan....*See* Methorphan									
Racemorphan....*See* Orphan									
Sinomenine Hydrochloride Dihydrate	80	6.11	9.62	6.75	11.5	100	75	75	40
Thebaine (free base)	81	7.76	5.11	3.73	7.76	100	90	90	100
Thebaine Hydrochloride	82	7.44	3.47	4.88	7.44	100	60	50	100
Thebenine Hydrochloride Monohydrate*	83	4.45	3.47	10.7	10.7	100	75	60	60

Innermost line index

The maximum spacing (d for the "innermost line") observed among the narcotics investigated varied from almost 20Å to approximately 7Å. Measurement (with a pocket rule graduated in millimeters) of the diameter of the "innermost line" of the pattern of an "unknown" even when the film has only just cleared in the fixer often will serve to limit the choice of possible substances.

In the following index the narcotics are arranged in the order of the interplanar spacings represented by their innermost lines. It must be remembered that the patterns were obtained in a 114.6mm. diameter camera with Co radiation, and that the maximum spacing observable (the "cut-off") was 20Å. Thus the lines with the largest spacings would not be observed with copper radiation or with a camera of smaller radius, while a larger camera or chromium radiation might reveal lines of d above the 20Å limit. In the first case a similar index can be drawn up from the tabulated data by first determining the "cut-off" for the equipment at hand and taking the first line of lower d as the innermost line. It is improbable that more than the first few substances could have d's larger than the maximum observed but their presence in films obtained under conditions with a "cut-off" at higher values should cause no difficulty.

In the index, the d for the innermost line is followed by the relative intensity, I/I_1, for that line. It should be borne in mind, however, that these values are relative to 100 for the strongest line of that particular pattern; the intensities are not on an absolute scale. In six cases the relative intensity is very low (<5) and, therefore, the lines may not be observed if relatively short exposure times are used. Hence the next line of lower d (which is a strong line in each case) is included in the index; these entries are enclosed in square brackets.

The number after each name is the same as that in the *Alphabetical Index* and corresponds to the Figure Number of the corresponding diffraction pattern.

Innermost Line Index

d	I/I_1	Name	No.
19.6	15	Mescaline Sulphate Dihydrate	33
18.3	12	*dl*-Methorphan Hydrobromide Dihydrate	40
17.6	10	Diamorphine Hydrochloride Monohydrate	15
17.0	20	Codeine Phosphate Dihydrate	11
16.6	10	Dihydrocodeinone Bitartrate (Dihydrate?)	18
16.4	25	Narcotine Hydrochloride (III)	60
16.2	25	Narcotine (free base)	57
16.1	20	Codeine Phosphate (anhydrous)	10
15.9	30	Narcotine Hydrochloride (II)	59
15.3	15	Morphine Tartrate Monohydrate	53
15.1	50	*dl*-α-Prodine Hydrochloride	75
15.0	70	Morphine Sulphate Pentahydrate	52
14.8	60	Hydroxypethidine (free base)	26
14.8	30	Narcotine Hydrochloride (I)	58
14.8	10	Papaverine (free base)	68
14.7	20	*dl*-Orphan Hydrobromide	64
14.3	15	Morphine Sulphate Dihydrate	51
13.9	50	Hydroxypethidine Hydrochloride	27
13.8	100	Narceine (free base)	56
13.7	40	*d*-, and *l*-Methorphan Hydrobromide Monohydrate	39
13.3	90	Ethylpethidine Hydrochloride	24
13.1	15	*dl*-Isomethadone Hydrochloride Monohydrate	28
12.8	30	Phenadoxone Hydrochloride	73
12.6	75	Ethylnarceine Hydrochloride	23
12.6	30	*dl*-Methadone Hydrobromide	35
12.4	30	Dioxyline Phosphate	21
12.4	15	*d*-, and *l*-Methadone Hydrochloride	36
12.4	25	*dl*-Methadone Hydrochloride	37
12.2	40	Neopine Hydrobromide	61
11.6	15	Acedicon® Hydrochloride	1
11.6	2	Oxycodone Hydrochloride	67
11.5	40	Sinomenine Hydrochloride Dihydrate	80
11.2	10	Apomorphine Hydrochloride	3
11.2	20	Ethylmorphine Hydrochloride	22
11.2	20	*dl*-β-Prodine Hydrochloride	76
11.1	60	Acetoxyketobemidone Hydrochloride	2
11.1	1	Morphine Hydrochloride Trihydrate	48
11.1	60	Opianic Acid	62
11.0	50	Morphine Hydriodide Dihydrate	46
10.8	40	Pipidone Hydrochloride	74
10.7	90	Cocaine Hydrochloride	7
10.7	10	Diamorphine (free base)	14
10.7	20	Protopine (free base)	78
10.7	60	Thebenine Hydrochloride Monohydrate	83
10.6	100	Morphothebaine Hydrochloride	54
[10.6	100	Oxycodone Hydrochloride	67]
10.6	100	Propylketobemidone (free base)	77
10.5	20	Nalorphine Hydrochloride	55
10.5	20	Oxycodone (free base)	66
10.4	25	α-Monoacetylmorphine (free base)	45
[10.4	85	Morphine Hydrochloride Trihydrate	48]
10.3	20	*dl*-Methorphan (free base)	38
10.1	15	Codeine (anhydrous free base)	8
10.1	15	Dihydrocodeinone (free base)	17
10.1	20	Dihydromorphine Monohydrate (free base)	19
10.1	100	Metopon (Dihydrate?) (free base)	43
10.1	30	Morphine Monohydrate (free base)	49
10.1	20	Papaverine Hydrochloride	69
9.86	60	Meconic Acid Trihydrate	32
9.78	100	Benzylmorphine Hydrochloride	5
9.73	3	Morphine-N-oxide (free base)	50
9.72	50	Cocaine (free base)	6
9.69	40	*dl*-Laudanine (free base)	31
9.63	10	Dihydrocodeine (free base)	16
9.63	25	Methylketobemidone Hydrochloride	42
9.62	50	Dihydromorphinone Hydrochloride	20
9.50	40	Hydrastinine Hydrochloride Monohydrate	25
9.49	100	Pethidine (free base)	70
9.46	50	Ketobemidone Hydrochloride	30
9.41	1	*d*-, *l*-, and *dl*-Methadone (free base)	34
9.39	3	*d*-, and *l*-Orphan Tartrate Dihydrate	65
9.23	30	Pseudomorphine Trihydrate (free base)	79
8.79	25	Phenadoxone (free base)	72
8.77	3	Ketobemidone (free base)	29
8.76	90	Codeine Monohydrate (free base)	9
8.58	90	Benzylmorphine (free base)	4
8.56	75	Methylketobemidone (free base)	41
[8.44	60	Ketobemidone (free base)	29]
[8.36	100	*d*-, *l*-, and *dl*-Methadone (free base)	34]
8.28	15	Metopon Hydrochloride	44
8.28	40	*dl*-Orphan (free base)	63
[8.23	100	*d*-, and *l*-Orphan Tartrate Dihydrate	65]
8.12	5	Morphine Hydrochloride (anhydrous)	47
8.04	100	Pethidine Hydrochloride	71
7.76	100	Thebaine (free base)	81
[7.70	25	Morphine-N-oxide (free base)	50]
7.44	100	Thebaine Hydrochloride	82
7.36	40	Cryptopine (free base)	13
7.05	60	Cotarnine (free base)	12
[6.79	100	Morphine Hydrochloride (anhydrous)	47]

NUMERICAL (HANAWALT) INDEX AND TABULATED (d, I/I_1) DATA

For the convenience of those familiar with the A.S.T.M. Index (1) the data are listed numerically according to the same scheme employed in the "blue" pages of *A.S.T.M. Special Technical Publication No. 48-D.* The three strongest lines of each pattern are indexed three times according to spacings (d), namely in the order 1-2-3, 2-1-3, and 3-1-2 where 1,2,3 refer to the relative strength of the three strongest lines. The first d of each of these triplets determines the Hanawalt Group in which the three lines are placed. Within each group the sets of lines are listed in descending order of d for the second line of the triplet; if the second lines have the same d, the order (descending) of the third line is used. On each line of type the three d values are printed in sequence followed by the corresponding values of I/I_1 in the same order and then by the name of the substance and the Figure Number (in parentheses). At the beginning of each Hanawalt Group is given the group number and the range of values of d (the first of each triplet) represented in the group.

For example, the three strongest lines of the pattern of Cocaine Hydrochloride represent values of d = 5.88Å (I/I_1 = 100), 10.7Å (I/I_1 = 90), and 3.09Å (I/I_1 = 75), respectively. Cocaine Hydrochloride, therefore, will be found indexed under (1) 5.88, 10.7, 3.09; 100, 90, 75, under (2) 10.7, 5.88, 3.09; 90, 100, 75, and under (3) 3.09, 5.88, 10.7; 75, 100, 90. The first entry occurs in Hanawalt Group 72 (5.99 to 5.75Å) and at the top because 10.7Å is the largest spacing observed for the second line among the substances listed. The second entry appears in Hanawalt Group 81 (10.9 to 10.0Å) where it is the third from the top. The third entry is in Hanawalt Group 45 (3.09 to 3.05Å).

To use the numerical index, the spacings of the three strongest lines of the powder pattern of the "unknown" are determined and a visual estimate of their relative intensities is made. The Hanawalt Group that includes the spacing of the strongest line of the pattern is found. Some allowance for possible errors in measurement must be made, say about 0.1Å for $d > 10$Å, about 0.05Å for d between 10 and 5Å, and 0.02 to 0.01Å for d between 5 and 1Å.

If d for the strongest line of an "unknown" pattern has a value close to that of one of the limits of a Hanawalt Group, the Group which it approaches should be included in the search. Thus Ketobemidone (free base) in Hanawalt Group 63 with d = 4.49Å for the spacing of the strongest line, might on another measurement have been listed in Group 64 with d = 4.50 or 4.51Å.

Having selected the Hanawalt Group (or Groups) in which the data for the "unknown" are to be expected, the second column is examined for a value of d equal (or almost equal) to that found for the second strongest line. If a reasonable match is obtained, the d's for the first and third lines and the relative intensities of all three lines in the index are compared with the observed data. If there is reasonable agreement, the complete pattern of the "unknown" is compared with the Tabulated (d, I/I_1) Data (immediately following the numerical index) for the substance suspected, or the film may be compared directly with the corresponding Figure bearing in mind that some distortion (usually a slight expansion) may have occurred during the various stages through which it has passed from the original negative to the final reproduction. It is preferable to use cobalt radiation; otherwise allowance must be made for appreciable contraction or expansion of the pattern if a different radiation (such as copper or chromium) has been employed, and for possible variations in relative intensities.

If the three strongest lines of the "unknown" are *not* found in the numerical index, when a search is made in the Hanawalt Group for the strongest line, the search should be repeated in the Groups corresponding to the second and third strongest lines, respectively. This helps to circumvent differences in the appraisal of relative intensities by different observers.

In the tabulated data following the numerical index, powder lines that were abnormally broad in a particular pattern are indicated by "B" or "BB" after the value of I/I_1 for the particular lines concerned; such lines generally represent two, or more, that were not resolved.

Numerical Index

				83. *13.9 to 12.0*		
13.3	6.93	4.46	90	100	80	Ethylpethidine Hydrochloride (24)
12.6	4.37	6.34	75	100	90	Ethylnarceine Hydrochloride (23)
13.8	4.14	5.08	100	50	45	Narceine (free base) (56)
				82. *11.9 to 11.0*		
11.1	7.39	3.39	60	100	60	Opianic Acid (62)
11.6	6.77	8.16	60	100	65	Narcotine Hydrochloride (III) (60)
				81. *10.9 to 10.0*		
10.6	8.18	6.76	75	100	90	Narcotine Hydrochloride (II) (59)
10.6	7.28	5.44	100	90	75	Oxycodone Hydrochloride (67)
10.4	6.11	3.95	85	100	100	Morphine Hydrochloride Trihydrate (48)
10.7	5.88	3.09	90	100	75	Cocaine Hydrochloride (7)
10.1	5.59	9.13	100	95	75	Metopon (Dihydrate?) (free base) (43)

81. *10.9 to 10.0 (continued)*

10.6	5.02	5.77	100	90	50	Propylketobemidone (free base) (77)
10.4	4.81	4.22	100	80	75	Acedicon® Hydrochloride (1)
10.7	4.45	3.47	60	100	75	Thebenine Hydrochloride Monohydrate (83)
10.6	3.75	3.54	100	100	100	Morphothebaine Hydrochloride (54)

80. *9.99 to 9.50*

9.62	6.11	6.75	75	100	75	Sinomenine Hydrochloride Dihydrate (80)
9.72	4.41	7.38	50	100	60	Cocaine (free base) (6)
9.78	3.63	5.35	100	90	80	Benzylmorphine Hydrochloride (5)
9.86	3.24	2.48	60	100	50	Meconic Acid Trihydrate (32)

79. *9.49 to 9.00*

9.13	10.1	5.59	75	100	95	Metopon (Dihydrate?) (free base) (43)
9.49	5.46	4.79	100	80	60	Pethidine (free base) (70)
9.03	5.17	7.26	100	90	80	Diamorphine Hydrochloride Monohydrate (15)

78. *8.99 to 8.50*

8.76	6.54	4.44	75	100	75	Pseudomorphine Trihydrate (free base) (79)
8.76	4.85	6.73	90	100	50	Codeine Monohydrate (free base) (9)

77. *8.49 to 8.00*

8.16	6.77	11.6	65	100	60	Narcotine Hydrochloride (III) (60)
8.18	6.76	10.6	100	90	75	Narcotine Hydrochloride (II) (59)
8.36	6.74	4.70	100	90	75	*d*-, *l*-, and *dl*-Methadone (free base) (34)
8.13	5.87	5.10	100	70	70	*dl*-β-Prodine Hydrochloride (76)
8.44	5.12	4.28	100	90	80	Dihydrocodeinone Bitartrate (Dihydrate?) (18)
8.44	4.49	5.08	60	100	40	Ketobemidone (free base) (29)
8.08	4.40	4.03	100	90	80	Apomorphine Hydrochloride (3)
8.23	4.13	5.69	100	75	50	*d*-, and *l*-Orphan Tartrate Dihydrate (65)
8.10	3.92	5.69	80	100	80	Ethylmorphine Hydrochloride (22)
8.04	3.61	4.67	100	90	75	Pethidine Hydrochloride (71)
8.09	3.46	5.17	60	100	80	Hydrastinine Hydrochloride Monohydrate (25)

76. *7.99 to 7.50*

7.97	6.40	4.23	75	100	80	Narcotine Hydrochloride (I) (58)
7.62	6.20	4.50	45	100	90	Phenadoxone (free base) (72)
7.70	5.88	5.21	40	100	50	Oxycodone (free base) (66)
7.58	5.80	4.11	100	100	100	Benzylmorphine (free base) (4)
7.79	5.35	4.68	40	100	50	Morphine Tartrate Monohydrate (53)
7.76	5.11	3.73	100	90	90	Thebaine (free base) (81)
7.58	4.60	6.52	90	100	80	*dl*-Methadone Hydrobromide (35)
7.50	4.57	6.48	90	100	70	*dl*-Methadone Hydrochloride (37)
7.50	4.55	5.35	75	100	75	Hydroxypethidine (free base) (26)
7.69	4.28	5.98	80	100	90	Methylketobemidone (free base) (41)
7.64	3.49	6.22	75	100	50	Narcotine (free base) (57)

75. *7.49 to 7.00*

7.39	11.1	3.39	100	60	60	Opianic Acid (62)
7.28	10.6	5.44	90	100	75	Oxycodone Hydrochloride (67)
7.26	9.03	5.17	80	100	90	Diamorphine Hydrochloride Monohydrate (15)
7.07	6.55	4.75	70	100	75	α-Monoacetylmorphine (free base) (45)
7.05	6.39	3.53	60	100	100	Cotarnine (free base) (12)
7.10	6.33	6.16	80	100	80	Dihydrocodeine (free base) (16)
7.18	6.26	4.28	40	100	40	Morphine Sulphate Dihydrate (51)
7.41	6.01	4.18	75	100	60	Dihydromorphine Monohydrate (free base) (19)
7.42	5.98	6.61	60	100	60	Morphine Monohydrate (free base) (49)
7.14	5.96	6.69	100	80	70	*dl*-α-Prodine Hydrochloride (75)
7.25	5.83	5.28	100	75	50	*dl*-Isomethadone Hydrochloride Monohydrate (28)
7.00	5.29	5.08	75	100	50	Diamorphine (free base) (14)
7.33	5.06	6.91	80	100	80	Nalorphine Hydrochloride (55)
7.08	4.94	4.19	100	80	50	Pipidone Hydrochloride (74)
7.43	4.42	4.73	40	100	30	*d*-, and *l*-Methadone Hydrochloride (36)
7.38	4.41	9.72	60	100	50	Cocaine (free base) (6)
7.44	3.47	4.88	100	60	50	Thebaine Hydrochloride (82)

74. *6.99 to 6.50*

6.93	13.3	4.46	100	90	80	Ethylpethidine Hydrochloride (24)
6.54	8.76	4.44	100	75	75	Pseudomorphine Trihydrate (free base) (79)
6.74	8.36	4.70	90	100	75	*d*-, *l*-, and *dl*-Methadone (free base) (34)
6.76	8.18	10.6	90	100	75	Narcotine Hydrochloride (II) (59)
6.77	8.16	11.6	100	65	60	Narcotine Hydrochloride (III) (60)
6.69	7.14	5.96	70	100	80	*dl*-α-Prodine Hydrochloride (75)
6.74	6.30	3.86	65	100	80	Codeine Phosphate (anhydrous) (10)
6.75	6.11	9.62	75	100	75	Sinomenine Hydrochloride Dihydrate (80)
6.65	6.06	4.57	100	100	80	Dihydromorphinone Hydrochloride (20)

74. *6.99 to 6.50 (continued)*

6.61	5.98	7.42	60	100	60	Morphine Monohydrate (free base) (49)
6.79	5.95	4.16	100	80	60	Morphine Hydrochloride (anhydrous) (47)
6.91	5.06	7.33	80	100	80	Nalorphine Hydrochloride (55)
6.73	4.85	8.76	50	100	90	Codeine Monohydrate (free base) (9)
6.72	4.81	3.29	100	90	85	Mescaline Sulphate Dihydrate (33)
6.55	4.75	7.07	100	75	70	α-Monoacetylmorphine (free base) (45)
6.94	4.65	3.86	40	100	50	*dl*-Methorphan Hydrobromide Dihydrate (40)
6.52	4.60	7.58	80	100	90	*dl*-Methadone Hydrobromide (35)
6.79	4.30	4.08	100	60	60	*dl*-Laudanine (free base) (31)
6.96	4.22	6.49	80	100	80	Metopon Hydrochloride (44)
6.64	3.90	5.14	90	100	90	*dl*-Methorphan (free base) (38)
6.91	3.59	4.24	100	50	40	Dioxyline Phosphate (21)
6.55	3.51	5.06	100	60	40	Codeine Phosphate Dihydrate (11)

73. *6.49 to 6.00*

6.11	9.62	6.75	100	75	75	Sinomenine Hydrochloride Dihydrate (80)
6.01	7.41	4.18	100	75	60	Dihydromorphine Monohydrate (free base) (19)
6.26	7.18	4.28	100	40	40	Morphine Sulphate Dihydrate (51)
6.33	7.10	6.16	100	80	80	Dihydrocodeine (free base) (16)
6.06	6.65	4.57	100	100	80	Dihydromorphinone Hydrochloride (20)
6.16	6.33	7.10	80	100	80	Dihydrocodeine (free base) (16)
6.22	5.84	4.15	60	100	75	*dl*-Orphan (free base) (63)
6.33	5.76	4.90	85	100	90	Acetoxyketobemidone Hydrochloride (2)
6.39	5.20	3.84	100	100	90	Phenadoxone Hydrochloride (73)
6.48	4.57	7.50	70	100	90	*dl*-Methadone Hydrochloride (37)
6.20	4.50	7.62	100	90	45	Phenadoxone (free base) (72)
6.34	4.37	12.6	90	100	75	Ethylnarceine Hydrochloride (23)
6.20	4.37	3.68	100	90	80	Morphine Sulphate Pentahydrate (52)
6.40	4.23	7.97	100	80	75	Narcotine Hydrochloride (I) (58)
6.49	4.22	6.96	80	100	80	Metopon Hydrochloride (44)
6.04	4.20	5.64	100	90	80	Neopine Hydrobromide (61)
6.11	3.95	10.4	100	100	85	Morphine Hydrochloride Trihydrate (48)
6.03	3.89	4.72	60	100	70	Morphine Hydriodide Dihydrate (46)
6.30	3.86	6.74	100	80	65	Codeine Phosphate (anhydrous) (10)
6.49	3.78	4.83	100	75	40	Dihydrocodeinone (free base) (17)
6.47	3.77	4.89	100	75	60	Codeine (anhydrous free base) (8)
6.39	3.53	7.05	100	100	60	Cotarnine (free base) (12)
6.22	3.49	7.64	50	100	75	Narcotine (free base) (57)

72. *5.99 to 5.75*

5.88	10.7	3.09	100	90	75	Cocaine Hydrochloride (7)
5.77	10.6	5.02	50	100	90	Propylketobemidone (free base) (77)
5.87	8.13	5.10	70	100	70	*dl*-β-Prodine Hydrochloride (76)
5.80	7.58	4.11	100	100	100	Benzylmorphine (free base) (4)
5.98	7.42	6.61	100	60	60	Morphine Monohydrate (free base) (49)
5.83	7.25	5.28	75	100	50	*dl*-Isomethadone Hydrochloride Monohydrate (28)
5.96	7.14	6.69	80	100	70	*dl*-α-Prodine Hydrochloride (75)
5.95	6.79	4.16	80	100	60	Morphine Hydrochloride (anhydrous) (47)
5.88	5.21	7.70	100	50	40	Oxycodone (free base) (66)
5.76	4.90	6.33	100	90	85	Acetoxyketobemidone Hydrochloride (2)
5.82	4.80	3.36	100	60	60	Methylketobemidone Hydrochloride (42)
5.96	4.47	4.36	90	100	80	Protopine (free base) (78)
5.98	4.28	7.69	90	100	80	Methylketobemidone (free base) (41)
5.84	4.15	6.22	100	75	60	*dl*-Orphan (free base) (63)
5.79	3.73	3.87	100	90	85	Papaverine (free base) (68)

71. *5.74 to 5.50*

5.59	10.1	9.13	95	100	75	Metopon (Dihydrate?) (free base) (43)
5.69	8.23	4.13	50	100	75	*d*-, and *l*-Orphan Tartrate Dihydrate (65)
5.64	6.04	4.20	80	100	90	Neopine Hydrobromide (61)
5.63	5.20	3.83	60	100	90	*d*-, and *l*-Methorphan Hydrobromide Monohydrate (39)
5.71	5.18	3.72	100	50	50	Morphine-N-oxide (free base) (50)
5.53	5.00	3.75	70	100	75	Hydroxypethidine Hydrochloride (27)
5.53	3.94	3.31	100	90	75	*dl*-Orphan Hydrobromide (64)
5.69	3.92	8.10	80	100	80	Ethylmorphine Hydrochloride (22)
5.56	2.83	4.01	100	80	60	Cryptopine (free base) (13)

70. *5.49 to 5.25*

5.44	10.6	7.28	75	100	90	Oxycodone Hydrochloride (67)
5.35	9.78	3.63	80	100	90	Benzylmorphine Hydrochloride (5)
5.46	9.49	4.79	80	100	60	Pethidine (free base) (70)
5.28	7.25	5.83	50	100	75	*dl*-Isomethadone Hydrochloride Monohydrate (28)
5.29	7.00	5.08	100	75	50	Diamorphine (free base) (14)

70. *5.49 to 5.25 (continued)*

5.35	4.68	7.79	100	50	40	Morphine Tartrate Monohydrate (53)
5.35	4.55	7.50	75	100	75	Hydroxypethidine (free base) (26)

69. *5.24 to 5.00*

5.08	13.8	4.14	45	100	50	Narceine (free base) (56)
5.02	10.6	5.77	90	100	50	Propylketobemidone (free base) (77)
5.17	9.03	7.26	90	100	80	Diamorphine Hydrochloride Monohydrate (15)
5.12	8.44	4.28	90	100	80	Dihydrocodeinone Bitartrate (Dihydrate?) (18)
5.10	8.13	5.87	70	100	70	*dl*-β-Prodine Hydrochloride (76)
5.11	7.76	3.73	90	100	90	Thebaine (free base) (81)
5.06	7.33	6.91	100	80	80	Nalorphine Hydrochloride (55)
5.06	6.55	3.51	40	100	60	Codeine Phosphate Dihydrate (11)
5.20	6.39	3.84	100	100	90	Phenadoxone Hydrochloride (73)
5.21	5.88	7.70	50	100	40	Oxycodone (free base) (66)
5.18	5.71	3.72	50	100	50	Morphine-N-oxide (free base) (50)
5.08	5.29	7.00	50	100	75	Diamorphine (free base) (14)
5.12	4.56	3.57	75	100	75	Papaverine Hydrochloride (69)
5.08	4.49	8.44	40	100	60	Ketobemidone (free base) (29)
5.14	3.90	6.64	90	100	90	*dl*-Methorphan (free base) (38)
5.20	3.83	5.63	100	90	60	*d*-, and *l*-Methorphan Hydrobromide Monohydrate (39)
5.00	3.75	5.53	100	75	70	Hydroxypethidine Hydrochloride (27)
5.09	3.67	3.81	100	75	60	Ketobemidone Hydrochloride (30)
5.17	3.46	8.09	80	100	60	Hydrastinine Hydrochloride Monohydrate (25)

68. *4.99 to 4.90*

4.90	7.08	4.19	80	100	50	Pipidone Hydrochloride (74)
4.90	5.76	6.33	90	100	85	Acetoxyketobemidone Hydrochloride (2)

67. *4.89 to 4.80*

4.81	10.4	4.22	80	100	75	Acedicon® Hydrochloride (1)
4.85	8.76	6.73	100	90	50	Codeine Monohydrate (free base) (9)
4.88	7.44	3.47	50	100	60	Thebaine Hydrochloride (82)
4.81	6.72	3.29	90	100	85	Mescaline Sulphate Dihydrate (33)
4.83	6.49	3.78	40	100	75	Dihydrocodeinone (free base) (17)
4.89	6.47	3.77	60	100	75	Codeine (anhydrous free base) (8)
4.80	5.82	3.36	60	100	60	Methylketobemidone Hydrochloride (42)

66. *4.79 to 4.70*

4.79	9.49	5.46	60	100	80	Pethidine (free base) (70)
4.70	8.36	6.74	75	100	90	*d*-, *l*-, and *dl*-Methadone (free base) (34)
4.75	6.55	7.07	75	100	70	α-Monoacetylmorphine (free base) (45)
4.73	4.42	7.43	30	100	40	*d*-, and *l*-Methadone Hydrochloride (36)
4.72	3.89	6.03	70	100	60	Morphine Hydriodide Dihydrate (46)

65. *4.69 to 4.60*

4.67	8.01	3.61	75	100	90	Pethidine Hydrochloride (71)
4.60	7.58	6.52	100	90	80	*dl*-Methadone Hydrobromide (35)
4.68	5.35	7.79	50	100	40	Morphine Tartrate Monohydrate (53)
4.65	3.86	6.94	100	50	40	*dl*-Methorphan Hydrobromide Dihydrate (40)

64. *4.59 to 4.50*

4.57	7.50	6.48	100	90	70	*dl*-Methadone Hydrochloride (37)
4.55	7.50	5.35	100	75	75	Hydroxypethidine (free base) (26)
4.57	6.65	6.06	80	100	100	Dihydromorphinone Hydrochloride (20)
4.50	6.20	7.62	90	100	45	Phenadoxone (free base) (72)
4.56	5.12	3.57	100	75	75	Papaverine Hydrochloride (69)

63. *4.49 to 4.40*

4.49	8.44	5.08	100	60	40	Ketobemidone (free base) (29)
4.40	8.08	4.03	90	100	80	Apomorphine Hydrochloride (3)
4.42	7.43	4.73	100	40	30	*d*-, and *l*-Methadone Hydrochloride (36)
4.41	7.38	9.72	100	60	50	Cocaine (free base) (6)
4.46	6.93	13.3	80	100	90	Ethylpethidine Hydrochloride (24)
4.44	6.54	8.76	75	100	75	Pseudomorphine Trihydrate (free base) (79)
4.47	5.96	4.36	100	90	80	Protopine (free base) (78)
4.45	3.47	10.7	100	75	60	Thebenine Hydrochloride Monohydrate (83)

62. *4.39 to 4.30*

4.30	6.79	4.08	60	100	60	*dl*-Laudanine (free base) (31)
4.37	6.34	12.6	100	90	75	Ethylnarceine Hydrochloride (23)
4.37	6.20	3.68	90	100	80	Morphine Sulphate Pentahydrate (52)
4.36	4.47	5.96	80	100	90	Protopine (free base) (78)

61. *4.29 to 4.20*

4.22	10.4	4.81	75	100	80	Acedicon® Hydrochloride (1)
4.28	8.44	5.12	80	100	90	Dihydrocodeinone Bitartrate (Dihydrate?) (18)
4.22	6.96	6.49	100	80	80	Metopon Hydrochloride (44)
4.24	6.91	3.59	40	100	50	Dioxyline Phosphate (21)
4.23	6.40	7.97	80	100	75	Narcotine Hydrochloride (I) (58)
4.28	6.26	7.18	40	100	40	Morphine Sulphate Dihydrate (51)
4.20	6.04	5.64	90	100	80	Neopine Hydrobromide (61)
4.28	5.98	7.69	100	90	80	Methylketobemidone (free base) (41)

60. *4.19 to 4.10*

4.14	13.8	5.08	50	100	45	Narceine (free base) (56)
4.13	8.23	5.69	75	100	50	*d*-, and *l*-Orphan Tartrate Dihydrate (65)
4.11	7.58	5.80	100	100	100	Benzylmorphine (free base) (4)
4.19	7.08	4.94	50	100	80	Pipidone Hydrochloride (74)
4.16	6.79	5.95	60	100	80	Morphine Hydrochloride (anhydrous) (47)
4.18	6.01	7.41	60	100	75	Dihydromorphine Monohydrate (free base) (19)
4.15	5.84	6.22	75	100	60	*dl*-Orphan (free base) (63)

59. *4.09 to 4.00*

4.03	8.08	4.40	80	100	90	Apomorphine Hydrochloride (3)
4.08	6.79	4.30	60	100	60	*dl*-Laudanine (free base) (31)
4.01	5.56	2.83	60	100	80	Cryptopine (free base) (13)

58. *3.99 to 3.90*

3.92	8.10	5.69	100	80	80	Ethylmorphine Hydrochloride (22)
3.90	6.64	5.14	100	90	90	*dl*-Methorphan (free base) (38)
3.95	6.11	10.4	100	100	85	Morphine Hydrochloride Trihydrate (48)
3.94	5.53	3.31	90	100	75	*dl*-Orphan Hydrobromide (64)

57. *3.89 to 3.80*

3.84	6.39	5.20	90	100	100	Phenadoxone Hydrochloride (73)
3.86	6.30	6.74	80	100	65	Codeine Phosphate (anhydrous) (10)
3.87	5.79	3.73	85	100	90	Papaverine (free base) (68)
3.83	5.20	5.63	90	100	60	*d*-, and *l*-Methorphan Hydrobromide Monohydrate (39)
3.81	5.09	3.67	60	100	75	Ketobemidone Hydrochloride (30)
3.89	4.72	6.03	100	70	60	Morphine Hydriodide Dihydrate (46)
3.86	4.65	6.94	50	100	40	*dl*-Methorphan Hydrobromide Dihydrate (40)

56. *3.79 to 3.70*

3.75	10.6	3.54	100	100	100	Morphothebaine Hydrochloride (54)
3.73	7.76	5.11	90	100	90	Thebaine (free base) (81)
3.78	6.49	4.83	75	100	40	Dihydrocodeinone (free base) (17)
3.77	6.47	4.89	75	100	60	Codeine (anhydrous free base) (8)
3.73	5.79	3.87	90	100	85	Papaverine (free base) (68)
3.72	5.71	5.18	50	100	50	Morphine-N-oxide (free base) (50)
3.75	5.00	5.53	75	100	70	Hydroxypethidine Hydrochloride (27)

55. *3.69 to 3.60*

3.63	9.78	5.35	90	100	80	Benzylmorphine Hydrochloride (5)
3.61	8.04	4.67	90	100	75	Pethidine Hydrochloride (71)
3.68	6.20	4.37	80	100	90	Morphine Sulphate Pentahydrate (52)
3.67	5.09	3.81	75	100	60	Ketobemidone Hydrochloride (30)

54. *3.59 to 3.50*

3.54	10.6	3.75	100	100	100	Morphothebaine Hydrochloride (54)
3.59	6.91	4.24	50	100	40	Dioxyline Phosphate (21)
3.51	6.55	5.06	60	100	40	Codeine Phosphate Dihydrate (11)
3.53	6.39	7.05	100	100	60	Cotarnine (free base) (12)
3.57	4.56	5.12	75	100	75	Papaverine Hydrochloride (69)

53. *3.49 to 3.45*

3.49	7.64	6.22	100	75	50	Narcotine (free base) (57)
3.47	7.44	4.88	60	100	50	Thebaine Hydrochloride (82)
3.46	5.17	8.09	100	80	60	Hydrastinine Hydrochloride Monohydrate (25)
3.47	4.45	10.7	75	100	60	Thebenine Hydrochloride Monohydrate (83)

51. *3.39 to 3.35*

3.39	7.39	11.1	60	100	60	Opianic Acid (62)
3.36	5.82	4.80	60	100	60	Methylketobemidone Hydrochloride (42)

50. *3.34 to 3.30*

3.31	5.53	3.95	75	100	90	*dl*-Orphan Hydrobromide (64)

49. *3.29 to 3.25*

3.29	6.72	4.81	85	100	90	Mescaline Sulphate Dihydrate (33)

48. *3.24 to 3.20*

3.24	9.86	2.48	100	60	50	Meconic Acid Trihydrate (32)

45. *3.09 to 3.05*

3.09	5.88	10.7	75	100	90	Cocaine Hydrochloride (7)

40. *2.84 to 2.80*

2.83	5.56	4.01	80	100	60	Cryptopine (free base) (13)

33. *2.49 to 2.45*

2.48	3.24	9.86	50	100	60	Meconic Acid Trihydrate (32)

Tabulated (d, I/I_1) Data

1. *Acedicon® Hydrochloride*

d (Å)	I/I_1	d (Å)	I/I_1
11.6	15	2.76	2
10.4	100	2.67	12
8.20	60	2.56	3 B
6.86	30	2.46	3
6.46	40	2.40	20
6.16	15	2.36	1
5.86	60	2.32	2
5.56	15	2.26	25
5.33	8 B	2.23	2
4.81	80	2.19	23
4.59	60	2.15	2
4.52	10	2.11	5
4.40	30	2.06	15
4.22	75	1.98	3
3.91	20	1.94	5
3.70	70	1.84	10
3.57	60	1.81	2
3.44	10	1.78	4
3.27	50	1.70	4
3.04	20	1.65	1
2.97	60	1.63	2
2.84	5	1.60	2

2. *Acetoxyketobemidone Hydrochloride*

d (Å)	I/I_1	d (Å)	I/I_1
11.1	60	3.12	15
9.37	5	3.04	15
8.64	2	2.95	1
6.33	85	2.89	70 B
5.76	100	2.76	10
4.90	90	2.53	4
4.71	1	2.48	15
4.51	60	2.34	20
4.32	5	2.25	15
4.15	15	2.12	4
4.02	2	2.08	2
3.87	75	2.04	1
3.68	50	1.99	1
3.56	40 B	1.89	15 B
3.34	50	1.75	2
3.19	1	1.66	1

3. *Apomorphine Hydrochloride*

d (Å)	I/I_1	d (Å)	I/I_1
11.2	10	5.85	1
10.1	10	5.57	8
8.71	20	5.36	20
8.08	100	5.01	3
7.69	5	4.71	70
6.65	20	4.40	90
6.08	1	4.27	5

3. *Apomorphine Hydrochloride (continued)*

d (Å)	I/I_1	d (Å)	I/I_1
4.03	80	3.00	5
3.82	20	2.68	3 B
3.68	25	2.52	5
3.52	3	2.36	2
3.46	20	2.19	3
3.33	30	2.09	5
3.24	5	1.92	2 B
3.14	20	1.85	1 B

4. *Benzylmorphine (free base)*

d (Å)	I/I_1	d (Å)	I/I_1
8.58	90	3.35	10
7.58	100	3.24	5
7.27	40	3.02	3
5.80	100	2.93	30
5.65	90	2.87	2
5.31	20	2.66	2
4.85	80	2.62	2
4.65	1	2.58	2
4.37	30	2.39	10
4.29	10	2.20	10
4.11	100	2.16	2
3.87	90	2.04	2
3.72	5	2.01	10
3.63	1	1.91	3
3.56	75	1.83	2
3.46	2		

5. *Benzylmorphine Hydrochloride*

d (Å)	I/I_1	d (Å)	I/I_1
9.78	100	2.98	10
9.31	1	2.90	1
8.70	60	2.84	2
7.58	10	2.76	30
7.20	2	2.71	5
6.74	30	2.63	10
5.78	45	2.54	3
5.35	80	2.47	10
5.16	70	2.39	25
4.85	40	2.34	5
4.68	80	2.28	2
4.47	40	2.20	25
4.06	70	2.12	1
3.81	45	2.08	10
3.63	90	2.02	15 B
3.37	35	1.96	10
3.29	5	1.91	10 B
3.15	45	1.82	10
3.06	5	1.72	1

6. Cocaine (free base)

d (Å)	I/I₁	d (Å)	I/I₁
9.72	50	2.95	1
8.08	20	2.83	5
7.72	1	2.73	35
7.38	60	2.61	3
6.94	25	2.55	10
6.25	15	2.46	20
5.92	40	2.37	10 B
5.69	1	2.30	1
5.50	20	2.26	5
4.95	40	2.24	1
4.84	40	2.21	3
4.41	100	2.18	10
4.33	3	2.11	5 B
4.23	40	2.07	5
4.11	15	2.04	2
3.75	40	1.99	3
3.68	15	1.94	15
3.47	40	1.91	5
3.39	1	1.88	5
3.20	35	1.85	3 BB
3.13	10	1.77	1
3.07	1	1.74	5 B
3.01	20		

7. Cocaine Hydrochloride

d (Å)	I/I₁	d (Å)	I/I₁
10.7	90	3.09	75
9.87	2	3.02	10
9.23	50	2.95	15
7.44	5	2.82	10
7.15	25	2.74	25
6.16	2	2.68	1
5.88	100	2.54	25
5.57	1	2.49	12
5.35	25	2.42	1
5.17	15	2.33	25 B
4.95	1	2.28	2
4.78	50	2.20	30 B
4.65	50	2.03	20 B
4.38	25	1.97	30
4.28	25	1.92	25
4.18	5	1.85	10
4.05	5	1.81	5
3.97	30	1.76	2
3.77	1	1.72	2
3.68	1	1.67	3
3.58	35	1.65	2
3.51	35	1.60	20
3.41	10	1.56	10
3.34	10	1.53	5
3.25	20		

8. Codeine (anhydrous free base)

d (Å)	I/I₁	d (Å)	I/I₁
10.1	15	3.23	25 B
7.34	3	3.10	1
6.85	30	3.05	20
6.63	10 B	3.00	15
6.47	100	2.91	5
6.20	20	2.84	25
6.00	15	2.69	20
5.23	40	2.57	3
5.04	40	2.54	15
4.89	60	2.49	2
4.77	30	2.45	10
4.12	5 B	2.39	12
3.88	45	2.35	5
3.77	75	2.28	3
3.67	10	2.24	8
3.52	15 B	2.19	6
3.44	15	2.16	10
3.34	5	2.10	20

5. Codeine (anhydrous free base) (continued)

d (Å)	I/I₁	d (Å)	I/I₁
2.06	10	1.79	1
2.02	1	1.77	3 B
1.99	10	1.73	2
1.96	1	1.68	2
1.93	8	1.67	10
1.91	1	1.63	4
1.88	10	1.60	1
1.85	15	1.58	1
1.81	1	1.56	3

9. Codeine Monohydrate (free base)

d (Å)	I/I₁	d (Å)	I/I₁
8.76	90	2.97	15
8.11	20	2.88	2
6.73	50	2.81	12
6.32	20	2.72	3 B
5.59	25	2.64	12
5.25	40	2.44	4 B
4.85	100	2.38	2
4.52	1	2.33	5
4.37	8	2.25	10 B
4.05	20	2.20	2
3.96	10	2.14	10
3.85	15	2.10	10
3.72	30	2.00	1 B
3.44	1	1.90	5
3.36	30	1.87	1
3.30	15	1.80	2 B
3.05	2 B		

10. Codeine Phosphate (anhydrous)

d (Å)	I/I₁	d (Å)	I/I₁
16.1	20	3.04	8
12.6	5	2.95	2
8.04	25	2.89	5
7.45	10	2.75	8 B
7.05	8	2.61	1
6.74	65	2.57	15
6.30	100	2.51	5
6.00	4	2.46	5
5.79	60	2.35	8
5.49	6 B	2.30	3 B
5.17	30 B	2.24	5
4.90	5	2.17	8
4.72	10	2.11	12 B
4.51	10	2.05	3
4.29	10	2.00	4 B
4.17	3	1.93	4 B
4.06	20	1.87	1
3.97	5	1.84	1
3.86	80	1.72	1
3.64	2	1.68	1
3.56	1	1.63	1
3.50	1	1.57	1
3.41	50	1.51	1
3.29	5	1.47	1
3.14	25		

11. Codeine Phosphate Dihydrate

d (Å)	I/I₁	d (Å)	I/I₁
17.0	20	4.23	25
8.67	1	4.09	20
7.89	20	3.92	15 B
7.26	10	3.76	1
6.88	1	3.63	10
6.55	100	3.51	60
5.87	30	3.46	10 B
5.51	20	3.22	10
5.26	25	3.11	5
5.06	40	3.02	25
4.82	35	2.92	15
4.53	10	2.82	1
4.40	35	2.72	12

11. Codeine Phosphate Dihydrate (continued)

d (Å)	I/I_1	d (Å)	I/I_1
2.63	15	1.95	3
2.48	10	1.89	10
2.41	4	1.84	3
2.33	4	1.82	3
2.27	10	1.79	1
2.22	5	1.75	2
2.19	1	1.71	2
2.14	1	1.66	1
2.11	15	1.60	3
2.07	1	1.57	1
1.98	2	1.52	1

12. Cotarnine (free base)

d (Å)	I/I_1	d (Å)	I/I_1
7.05	60	2.56	10
6.39	100	2.45	3
5.31	60	2.36	20
5.03	40	2.31	20
4.82	30	2.25	3 B
4.43	1 B	2.16	8
4.20	20	2.08	15
4.04	60	2.01	5
3.92	40	1.98	1
3.77	3	1.95	8
3.53	100	1.90	2
3.44	3 B	1.88	8
3.27	1 B	1.84	2
3.20	10	1.77	15
3.06	45	1.71	3
2.99	15	1.63	1
2.79	10	1.60	1
2.69	10	1.57	5
2.61	1	1.53	1

13. Cryptopine (free base)

d (Å)	I/I_1	d (Å)	I/I_1
7.36	40 B	2.49	5
6.57	40	2.33	30
5.56	100	2.30	1
5.18	20	2.18	10
4.56	25	2.14	5
4.33	5	2.05	20
4.17	50	1.97	5
4.01	60	1.93	15
3.71	60	1.88	1
3.58	15	1.85	2
3.46	5	1.82	10
3.29	40	1.77	5
3.21	1	1.74	15 B
3.14	10	1.68	1
3.03	5	1.66	25
2.98	2	1.62	10
2.90	15	1.57	5
2.83	80	1.52	5
2.76	2	1.43	2
2.69	2	1.41	2
2.60	30		

14. Diamorphine (free base)

d (Å)	I/I_1	d (Å)	I/I_1
10.7	10	3.66	20
9.25	1	3.50	50
8.10	30	3.21	25
7.00	75 B	3.08	5
6.54	45 B	2.93	1
5.66	1	2.81	8
5.29	100	2.67	30
5.08	50	2.52	5
4.46	15	2.48	2
4.28	1	2.40	2
4.13	50	2.37	2
4.02	50	2.31	20
3.88	20	2.25	2
3.75	2	2.20	3

14. Diamorphine (free base) (continued)

d (Å)	I/I_1	d (Å)	I/I_1
2.13	10	1.79	2
2.07	2	1.74	5
1.99	5	1.69	1
1.93	1	1.64	2
1.89	3	1.57	1
1.83	2		

15. Diamorphine Hydrochloride Monohydrate

d (Å)	I/I_1	d (Å)	I/I_1
17.6	10	3.23	20
9.03	100	3.02	35
7.55	5	2.91	20
7.26	80	2.85	3
6.97	10	2.80	1
6.73	10	2.66	8
6.44	75	2.61	8
5.83	30	2.54	1
5.35	35	2.49	1
5.27	2 B	2.39	35 B
5.17	90	2.31	10
4.96	35	2.21	1
4.77	20	2.15	15 B
4.61	10	2.01	1 B
4.49	2	1.98	1
4.28	40	1.94	1
4.07	35 B	1.92	1
3.76	80 B	1.85	3
3.58	40	1.78	5
3.39	60		

16. Dihydrocodeine (free base)

d (Å)	I/I_1	d (Å)	I/I_1
9.63	10	2.61	20
7.10	80	2.57	10
6.82	5 B	2.52	10
6.33	100	2.47	1
6 16	80	2.41	20
5.31	50	2.34	8
5.13	1	2.27	15
4.95	40	2.25	2
4.36	50	2.18	3
4.18	75	2.15	30
4.00	25 B	2.11	3
3.82	50	2.08	3
3.54	1	2.06	1
3.46	50	2.00	20
3.35	30	1.96	2
3.30	2	1.94	10
3.23	2	1.92	4
3.16	2	1.88	2 B
3.08	50	1.82	2 B
3.00	1	1.77	5
2.85	2	1.70	4
2.80	10	1.65	2 B
2.74	1	1.61	8 B
2.66	25	1.56	1 B

17. Dihydrocodeinone (free base)

d (Å)	I/I_1	d (Å)	I/I_1
10.1	15	3.53	10
7.33	3	3.40	20
7.02	25	3.25	1
6.49	100	3.16	18
6.38	3	3.07	10
5.87	10	2.95	5
5.14	25	2.89	1
5.02	25	2.80	20
4.83	40	2.66	15
4.76	3	2.62	1
4.15	3	2.58	1
4.04	5	2.53	10
3.90	15	2.48	3
3.78	75	2.42	3
3.64	5 B	2.38	2

17. *Dihydrocodeinone (free base) (continued)*

d (Å)	I/I₁	d (Å)	I/I₁
2.32	1	1.97	1
2.23	2 B	1.93	3
2.19	1	1.90	3
2.17	2	1.85	8
2.12	8	1.80	2
2.06	8	1.74	3
2.03	3	1.62	2

18. *Dihydrocodeinone Bitartrate (Dihydrate?)*

d (Å)	I/I₁	d (Å)	I/I₁
16.6	10	3.40	40
12.8	40	3.27	60
9.82	10	3.19	5 B
9.35	20	3.07	12 B
8.44	100	2.95	4 B
7.40	50	2.83	4
6.94	3	2.72	4
6.40	60	2.62	15
6.18	60	2.43	3
5.68	8 B	2.34	10
5.43	5	2.29	25
5.12	90	2.26	2
4.92	15	2.22	4
4.73	40	2.18	2 B
4.44	1	2.07	1
4.28	80	1.99	1
3.90	80	1.91	1
3.68	5	1.85	1
3.60	5	1.78	1

19. *Dihydromorphine Monohydrate (free base)*

d (Å)	I/I₁	d (Å)	I/I₁
10.1	20	2.93	10
7.41	75	2.85	10
6.70	40	2.74	8
6.51	15	2.70	15
6.22	20	2.64	4
6.01	100	2.48	1
5.27	10	2.44	2
5.06	50	2.39	10
4.80	15	2.33	1
4.18	60	2.29	3
3.99	5 B	2.25	1
3.89	2	2.22	2
3.77	25	2.17	2
3.63	1	2.11	8
3.53	20	2.08	2
3.46	45	2.01	1 B
3.35	1	1.95	1
3.23	15	1.93	2
3.07	5	1.81	2
3.02	5		

20. *Dihydromorphinone Hydrochloride*

d (Å)	I/I₁	d (Å)	I/I₁
9.62	50	3.06	40
6.65	100	2.97	5
6.06	100 B	2.89	5
5.64	60	2.81	10 B
5.09	50	2.74	75
4.76	15	2.66	10
4.57	80	2.60	2
4.44	60	2.55	20
4.30	1	2.48	20
4.15	80	2.44	8
3.95	15	2.37	15 B
3.84	2	2.29	25
3.75	2	2.21	8
3.66	10	2.18	2
3.57	80	2.15	2
3.43	75	2.12	8
3.32	1	2.06	2
3.23	10	2.03	2

20. *Dihydromorphinone Hydrochloride (continued)*

d (Å)	I/I₁	d (Å)	I/I₁
1.99	3	1.67	1
1.93	15 B	1.62	2
1.89	5	1.56	3
1.86	5	1.52	2
1.83	15 B	1.49	1
1.79	1	1.39	1
1.78	2	1.35	1
1.74	2	1.24	1
1.68	10		

21. *Dioxyline Phosphate*

d (Å)	I/I₁	d (Å)	I/I₁
12.4	30	4.35	15
10.9	10	4.24	40
10.2	10	4.11	8 B
9.58	25	3.89	35
8.68	1	3.67	1
8.21	2	3.59	50
6.91	100	3.48	35
6.23	15	3.43	30
5.62	25	3.28	1
5.42	15	3.20	1
5.18	5	3.06	3 B
4.79	10	2.92	4 B
4.57	1		

22. *Ethylmorphine Hydrochloride*

d (Å)	I/I₁	d (Å)	I/I₁
11.2	20	2.42	15
10.3	50	2.38	1
8.10	80	2.33	10
6.32	2	2.24	3 B
6.09	70	2.17	1 B
5.69	80	2.12	40
5.46	1	2.06	8
5.23	40	2.03	20
5.11	10	1.99	30
4.78	75	1.96	15
4.56	10	1.88	35
4.31	10	1.83	10
4.08	10	1.79	25
3.92	100	1.75	1
3.67	15	1.73	3
3.51	40	1.68	2 B
3.39	40	1.64	2
3.28	40	1.62	2
3.17	40	1.59	4
3.11	50	1.56	4
3.05	1	1.53	4
2.98	60	1.50	8
2.92	3	1.46	3 B
2.85	3	1.40	3
2.78	75	1.37	2
2.71	15	1.33	3
2.63	25	1.22	5
2.58	3	1.20	3
2.52	2	1.17	2
2.45	15	1.15	4 B

23. *Ethylnarceine Hydrochloride*

d (Å)	I/I₁	d (Å)	I/I₁
12.6	75	4.22	20
10.9	20	4.12	20
10.1	75	4.03	75
9.37	3	3.92	70
7.02	30 B	3.71	60
6.72	35	3.52	50 B
6.34	90	3.43	10
6.02	40	3.35	20
5.75	1	3.21	20 B
5.03	40	3.03	15
4.82	15	2.91	20
4.66	15	2.82	5
4.37	100	2.77	2 B

23. Ethylnarceine Hydrochloride (continued)

d (Å)	I/I₁	d (Å)	I/I₁
2.67	10	2.40	2
2.58	3	2.09	2
2.51	15		

24. Ethylpethidine Hydrochloride

d (Å)	I/I₁	d (Å)	I/I₁
13.3	90	3.23	20
8.95	30	3.15	1 B
7.84	25	3.04	10 B
6.93	100	2.97	3 B
6.61	10	2.83	10
6.04	40	2.77	30
5.79	15	2.70	20
5.51	40	2.57	5 B
5.32	5	2.49	2
5.15	10	2.41	2
4.93	3	2.33	8
4.71	60	2.28	1
4.46	80	2.22	6 B
4.38	50	2.16	25
4.26	1	2.11	1
4.13	5	1.97	2
4.04	8	1.94	15
3.92	60	1.91	2
3.83	10	1.82	2
3.75	2	1.79	3
3.65	15	1.71	5
3.47	75	1.58	1
3.31	15		

25. Hydrastinine Hydrochloride Monohydrate

d (Å)	I/I₁	d (Å)	I/I₁
9.50	40	2.77	15
8.97	40	2.68	1
8.09	60	2.59	2
5.58	3	2.53	3
5.17	80	2.48	1
5.00	10	2.40	1
4.52	30	2.35	1
4.36	15	2.30	2
4.18	2	2.24	10
4.02	3	2.16	5
3.70	15	2.11	5
3.46	100	2.05	5
3.39	5	2.00	1
3.33	2	1.97	1
3.25	20	1.92	1
3.19	5	1.88	5
3.06	30	1.83	1
2.98	2	1.78	3
2.91	1	1.73	6 B
2.84	15	1.70	1

26. Hydroxypethidine (free base)

d (Å)	I/I₁	d (Å)	I/I₁
14.8	60	2.73	4
7.50	75	2.66	20
6.79	30	2.55	5
5.72	20	2.49	10
5.35	75	2.40	20
4.80	20	2.26	3
4.55	100	2.22	2
4.18	25	2.15	1
4.05	3	2.10	8
3.90	10	2.02	8
3.78	12	1.99	12 B
3.68	15	1.95	1 B
3.46	20	1.89	5
3.37	60	1.87	1
3.16	20	1.85	1
3.09	1	1.83	3
3.02	5	1.79	2
2.96	35	1.73	1
2.86	3	1.69	5
2.81	15		

27. Hydroxypethidine Hydrochloride

d (Å)	I/I₁	d (Å)	I/I₁
13.9	50	2.75	1
7.34	5	2.66	8
6.97	60	2.62	8
6.78	2	2.56	20
6.42	10	2.50	5
5.53	70	2.46	1 B
5.28	15	2.42	20
5.00	100	2.38	5 B
4.36	50	2.28	20
4.07	50	2.24	5
3.94	2 B	2.16	4
3.75	75	2.12	8
3.64	5	1.98	4
3.51	60	1.95	15
3.34	60	1.88	10
3.18	10	1.81	5
3.11	10	1.77	2
3.01	5	1.74	5
2.90	40	1.70	2
2.84	2	1.66	5
2.81	2		

28. dl-Isomethadone Hydrochloride Monohydrate

d (Å)	I/I₁	d (Å)	I/I₁
13.1	15	2.84	35
9.30	40	2.78	5
8.71	5	2.66	10
7.25	100	2.62	12
6.53	25	2.57	2
5.83	75	2.47	5
5.28	50	2.39	8
4.92	5	2.35	10
4.65	10	2.28	20
4.33	50	2.18	5 B
4.14	50	2.11	2
3.90	15	2.07	10
3.73	5	2.03	1
3.64	50	1.95	15 B
3.49	30	1.87	3 B
3.34	40	1.82	3
3.22	25	1.77	5 B
3.15	3	1.65	1
3.08	30	1.63	3
2.99	25	1.56	3

29. Ketobemidone (free base)

d (Å)	I/I₁	d (Å)	I/I₁
8.77	3	3.49	2
8.44	60	3.42	30
7.59	10	3.29	5
6.66	5	3.19	2
6.47	20	3.10	1
6.30	25	2.93	6
5.80	30	2.87	3
5.39	1	2.82	1
5.20	25	2.78	1
5.08	40	2.73	4
4.61	2 B	2.69	15
4.49	100	2.59	4
4.39	15	2.54	4
4.25	15	2.51	4
4.05	10	2.39	1 B
3.92	1	2.32	10 B
3.79	40	2.22	10
3.70	1	2.16	5
3.58	3		

30. Ketobemidone Hydrochloride

d (Å)	I/I₁	d (Å)	I/I₁
9.46	50	6.06	40
7.01	40	5.38	5
6.56	25	5.09	100
6.31	25	4.87	50

30. *Ketobemidone Hydrochloride (continued)*

d (Å)	I/I₁	d (Å)	I/I₁
4.71	50	2.49	2
4.28	25	2.46	1
4.14	50	2.40	3
4.04	3	2.35	5
3.81	60	2.31	10
3.67	75	2.23	12
3.50	3	2.14	8
3.40	25	2.07	5
3.35	10	2.03	3
3.31	10	1.99	1
3.14	3	1.97	5
3.09	15	1.93	2
3.03	10	1.89	5
2.97	15	1.84	8
2.92	5	1.78	1
2.87	4	1.75	1
2.79	2	1.71	1
2.74	20	1.68	1
2.64	4	1.61	3
2.60	1	1.57	1 B
2.56	40	1.52	1

31. *dl-Laudanine (free base)*

d (Å)	I/I₁	d (Å)	I/I₁
9.69	40	2.94	5
8.09	3	2.88	15
6.79	100	2.79	1
6.47	1	2.71	10
6.07	45	2.63	1
5.73	5	2.56	5
5.44	45	2.46	10 B
5.16	2	2.35	2
4.85	40	2.21	3
4.48	40 BB	2.16	20
4.30	60	2.10	5
4.08	60	2.04	2
3.87	1 B	2.00	10
3.76	20	1.94	5
3.66	10	1.88	5
3.49	15	1.82	10
3.38	50	1.77	2
3.05	30 B		

32. *Meconic Acid Trihydrate*

d (Å)	I/I₁	d (Å)	I/I₁
9.86	60	2.39	3
9.12	2 B	2.35	10
8.37	30	2.29	12
7.92	1	2.22	10 B
6.20	30	2.16	12
5.78	1	2.11	15
5.06	30 B	2.07	5
4.70	35	2.00	5
4.47	30 B	1.97	15
4.19	20	1.91	8
4.00	3	1.87	10
3.80	20	1.84	10 B
3.52	5	1.78	8 B
3.38	1	1.74	1 B
3.24	100	1.68	2 B
3.12	40 B	1.65	3
3.04	8 B	1.62	2
2.87	30	1.61	12
2.74	15	1.56	2 BB
2.66	5	1.51	2 BB
2.57	40	1.45	2 BB
2.48	50	1.41	5
2.43	1		

33. *Mescaline Sulphate Dihydrate*

d (Å)	I/I₁	d (Å)	I/I₁
19.6	15	6.72	100
10.1	3	6.25	60
7.72	1	6.02	1

33. *Mescaline Sulphate Dihydrate (continued)*

d (Å)	I/I₁	d (Å)	I/I₁
5.69	30	2.62	2
5.25	15	2.57	1
4.96	30 B	2.51	10
4.81	90	2.43	3 B
4.40	5	2.34	15
4.22	25	2.28	2
4.06	20	2.23	10
3.96	80	2.19	3 B
3.87	2	2.15	15
3.77	2	2.05	3
3.60	80	2.02	5
3.46	70	1.95	10
3.35	10	1.88	10
3.29	85	1.84	5 B
3.15	60	1.75	3
3.01	5	1.70	8
2.90	15	1.61	2
2.69	2 B		

34. *d-, l-, and dl-Methadone (free base)*

d (Å)	I/I₁	d (Å)	I/I₁
9.41	1	3.18	1
8.36	100	3.08	25
7.89	1	2.98	1
7.33	60	2.89	5
6.74	90	2.78	20
6.30	1	2.69	8
5.69	10	2.63	4
5.50	15	2.48	2
5.35	40	2.44	20
5.00	1	2.38	1
4.86	2	2.33	20
4.70	75	2.28	5
4.44	75	2.24	2
4.23	35 B	2.15	2
3.93	70	2.12	15
3.65	70	2.07	1
3.57	1	1.98	10
3.48	60	1.94	1
3.37	3	1.85	10
3.25	3		

35. *dl-Methadone Hydrobromide*

d (Å)	I/I₁	d (Å)	I/I₁
12.6	30	2.97	20 B
8.27	25	2.88	5
7.75	2	2.82	1
7.53	90	2.77	15
6.48	80	2.71	3
6.25	1	2.62	1
5.90	10	2.52	15 B
5.80	20	2.38	5
5.47	20	2.31	1
4.76	50	2.28	1
4.60	100	2.24	1
4.34	45	2.21	1
4.17	20	2.11	15 B
3.98	40 B	2.04	10 B
3.77	5	1.97	2
3.67	5	1.92	1 B
3.51	30 B	1.87	1 B
3.39	1	1.83	5
3.26	45	1.74	3
3.20	3	1.68	1
3.13	50	1.63	2
3.05	5		

36. *d-, and l-Methadone Hydrochioride*

d (Å)	I/I₁	d (Å)	I/I₁
12.4	15	6.08	15
8.09	20 B	5.62	1
7.67	2	5.41	1
7.43	40	4.73	30
6.37	2	4.61	1

36. d-, and l-Methadone Hydrochloride (continued)

d (Å)	I/I_1	d (Å)	I/I_1
4.42	100	3.08	20
4.14	20	2.90	1
3.95	3 B	2.85	1
3.76	15 B	2.77	2
3.55	1	2.69	1
3.35	2	2.58	3
3.18	20		

37. dl-Methadone Hydrochloride

d (Å)	I/I_1	d (Å)	I/I_1
12.4	25	3.10	30
8.25	10	3.03	3
7.87	5	2.97	10
7.50	90	2.92	3
6.48	70	2.84	5
6.20	1	2.75	20
5.92	20	2.68	15
5.70	5	2.60	3 B
4.72	30	2.53	20
4.57	100	2.48	2
4.34	40	2.30	5
4.20	3	2.23	1
4.14	20	2.16	2
4.00	20	2.11	8
3.87	20	2.08	3
3.71	5 BB	2.04	15
3.49	20 B	1.99	2
3.33	5	1.92	3
3.20	25	1.67	2
3.14	1 B		

38. dl-Methorphan (free base)

d (Å)	I/I_1	d (Å)	I/I_1
10.3	20	3.47	8 B
7.54	40	3.37	25
7.00	30	3.11	50 B
6.64	90	2.92	1 B
6.43	75	2.84	15
5.87	75	2.79	20
5.14	90	2.57	20
5.00	30	2.47	15
4.86	25	2.39	5
4.75	50	2.25	2 B
4.47	30	2.16	2
4.17	45	2.12	15
3.90	100	2.06	12 B
3.78	50	1.97	5 B
3.63	1	1.90	3 B
3.56	30		

39. d-, and l-Methorphan Hydrobromide Monohydrate

d (Å)	I/I_1	d (Å)	I/I_1
13.7	40	3.17	3
8.66	1	3.11	6
7.68	25	2.98	50
6.91	1	2.93	4
6.51	20	2.81	40
5.63	60	2.76	30
5.49	30	2.69	45
5.20	100	2.61	15
4.94	40	2.55	30
4.79	25	2.51	1
4.73	25	2.47	1
4.54	40	2.40	40
4.35	25	2.29	15
4.12	35	2.25	1
3.94	40	2.19	8 B
3.83	90	2.12	8 B
3.73	3	2.06	1 B
3.55	50	1.97	5 B
3.43	5	1.92	10
3.37	4	1.85	15
3.28	50	1.82	1
3.22	30	1.77	5

40. dl-Methorphan Hydrobromide Dihydrate

d (Å)	I/I_1	d (Å)	I/I_1
18.3	12	3.01	10 B
9.35	30	2.90	3 B
6.94	40	2.86	5
6.27	3	2.81	3 B
6.06	2	2.76	4
5.40	20	2.71	25
5.28	8	2.63	8
5.07	20	2.60	20
4.65	100	2.54	1
4.36	25	2.47	10
4.14	10	2.36	1
4.00	1	2.32	4
3.86	50	2.28	4
3.74	4	2.23	1
3.66	20	2.19	15
3.53	25	2.15	4 B
3.48	25	2.08	10
3.42	2	2.05	2 B
3.36	20	1.95	3 B
3.24	2 B	1.91	3
3.13	10 B	1.79	5
3.07	3		

41. Methylketobemidone (free base)

d (Å)	I/I_1	d (Å)	I/I_1
8.56	75	3.06	15
8.13	5	3.01	10
7.69	80	2.94	20
7.33	80	2.89	10
6.81	75	2.81	40
6.60	2	2.73	10 BB
5.98	90	2.59	3 BB
5.72	20	2.47	2
5.30	20	2.44	50
4.97	20	2.39	1
4.79	75	2.34	10
4.67	50	2.29	5
4.54	50	2.24	8
4.48	75	2.13	2
4.39	4	2.08	3 B
4.28	100	2.02	2
4.13	25	1.96	4 B
4.01	25	1.91	4
3.83	3	1.87	3
3.74	60	1.79	4
3.65	3 B	1.71	3
3.49	20	1.64	1
3.41	20	1.61	2
3.20	10 BB		

42. Methylketobemidone Hydrochloride

d (Å)	I/I_1	d (Å)	I/I_1
9.63	25	3.01	4
5.82	100	2.92	15
5.17	45	2.74	8 B
5.06	50	2.69	1
4.80	60	2.59	1
4.24	1	2.45	2
4.10	3	2.40	10
3.98	35	2.27	10
3.57	20	2.17	1
3.36	60	2.12	5
3.23	50	2.06	10
3.14	40		

43. Metopon (Dihydrate?) (free base)

d (Å)	I/I_1	d (Å)	I/I_1
10.1	100	4.87	40
9.13	75	4.53	30
7.37	60	4.13	50
5.88	40 B	4.00	4 B
5.59	95	3.80	5
5.03	2	3.73	75 B

43. *Metopon (Dihydrate?) (free base) (continued)*

d (Å)	I/I₁	d (Å)	I/I₁
3.57	65	2.41	1
3.50	2	2.34	10
3.43	2	2.29	10
3.35	20	2.25	3
3.29	4	2.19	25
3.19	1	2.12	3
3.11	4	2.03	5
2.87	40	2.01	1
2.81	1	1.95	5
2.75	20	1.90	2
2.69	25	1.82	5
2.65	1	1.71	5
2.48	7		

44. *Metopon Hydrochloride*

d (Å)	I/I₁	d (Å)	I/I₁
8.28	15	2.42	10
6.96	80	2.35	12 B
6.49	80	2.28	10
6.12	70	2.24	20
5.59	50	2.17	5
5.13	60	2.12	30
4.92	25	2.08	5
4.72	75	2.01	3
4.48	25	1.98	20
4.22	100	1.95	1
3.92	1	1.93	1
3.80	30	1.87	6
3.67	8 B	1.81	3 BB
3.57	1	1.75	5
3.50	70	1.71	6
3.35	1	1.67	2
3.17	40	1.64	2
2.95	15 B	1.61	5
2.87	1	1.55	2
2.80	15	1.51	2
2.74	60	1.48	2 B
2.70	2	1.44	2
2.58	3 BB	1.36	3
2.46	20		

45. *α-Monoacetylmorphine (free base)*

d (Å)	I/I₁	d (Å)	I/I₁
10.4	25	2.99	3
8.35	2	2.81	30
7.07	70	2.77	1
6.81	1	2.73	1
6.55	100	2.69	2
6.07	60	2.66	3
5.56	5	2.57	1
5.14	30	2.51	5
4.93	1	2.45	15
4.75	75	2.34	2 B
4.47	1	2.25	2 B
4.25	50	2.15	3 BB
3.99	1	2.03	1
3.70	60	1.99	4
3.60	20	1.97	2
3.52	10	1.92	2
3.45	10	1.89	1
3.30	12	1.85	2
3.25	2	1.81	3
3.19	15	1.77	2
3.12	4	1.66	1
3.03	15		

46. *Morphine Hydriodide Dihydrate*

d (Å)	I/I₁	d (Å)	I/I₁
11.0	50	5.21	60
8.04	1	4.72	70
6.49	35	4.57	3
6.03	60	4.27	10
5.75	20 B	4.10	1
5.47	1	3.89	100

46. *Morphine Hydriodide Dihydrate (continued)*

d (Å)	I/I₁	d (Å)	I/I₁
3.60	20	2.23	20 B
3.45	40	2.19	1
3.38	30	2.14	15
3.27	10 B	2.11	2
3.15	5	2.04	5 BB
3.09	40	1.98	5
3.00	5 B	1.92	25
2.94	20 B	1.87	3
2.83	8	1.82	2
2.78	3	1.79	1
2.73	2	1.76	1
2.67	5	1.74	1
2.61	15	1.69	3
2.51	1	1.63	1
2.41	20	1.61	1
2.37	15		

47. *Morphine Hydrochloride (anhydrous)*

d (Å)	I/I₁	d (Å)	I/I₁
8.12	5	2.69	8 BB
6.79	100	2.58	3
5.95	80	2.50	2 B
5.02	10	2.40	15
4.85	20	2.32	10
4.63	50	2.29	5
4.16	60	2.22	2
3.86	8	2.18	2
3.61	45	2.12	5
3.49	10	2.08	20
3.40	5 B	2.04	2
3.38	30	1.99	5
3.22	1	1.93	3
3.13	1 B	1.88	4
2.96	20	1.78	2 B
2.91	5 B	1.69	1 B
2.75	25 B		

48. *Morphine Hydrochloride Trihydrate*

d (Å)	I/I₁	d (Å)	I/I₁
11.1	1	2.81	20
10.4	85	2.76	3
8.11	75	2.68	3
6.11	100	2.62	1
5.80	85	2.52	25
5.22	50	2.46	15
4.87	40	2.39	5 BB
4.76	50	2.31	1 B
4.59	1	2.25	5 BB
4.32	20	2.16	25
4.15	20	2.07	25
3.95	100	2.03	1
3.63	10 B	2.00	25
3.50	60	1.96	1
3.42	30 B	1.93	10
3.33	10	1.90	1
3.19	10	1.87	15
3.11	70	1.84	1
3.01	50	1.73	1
2.94	25	1.70	3
2.88	1		

49. *Morphine Monohydrate (free base)*

d (Å)	I/I₁	d (Å)	I/I₁
10.1	30	4.04	5
7.42	60	3.94	5
7.05	1	3.77	2
6.61	60	3.72	10
6.23	35	3.61	2
5.98	100	3.55	5
5.25	10	3.46	60
5.05	60	3.35	1
4.92	1	3.19	10
4.78	15	3.07	10
4.17	60	2.99	5

49. Morphine Monohydrate (free base) (continued)

d (Å)	I/I1	d (Å)	I/I1
2.91	15	2.23	5
2.83	12	2.17	4
2.73	10	2.11	15 B
2.70	20	2.03	2
2.65	10	1.93	1
2.58	5	1.89	5
2.54	1	1.87	2
2.50	5	1.84	3
2.45	1	1.79	2
2.40	25	1.67	1
2.29	20	1.64	1

50. Morphine-N-oxide (free base)

d (Å)	I/I1	d (Å)	I/I1
9.73	3	2.52	15 B
7.70	25	2.40	12
6.34	40	2.36	10
6.09	5	2.28	8
5.93	1	2.25	3
5.71	100	2.21	2
5.18	50	2.18	15
4.88	10 BB	2.14	1
4.50	45	2.10	10
4.15	15	2.07	3
3.95	2 B	2.05	10
3.83	1	2.01	10
3.72	50	1.97	8
3.51	15 B	1.92	1
3.40	2 B	1.87	30 B
3.27	45	1.79	10 B
3.09	5	1.77	1
2.98	30	1.71	5
2.85	3	1.63	2
2.75	10	1.61	8
2.71	10	1.58	2
2.64	2	1.55	3

51. Morphine Sulphate Dihydrate

d (Å)	I/I1	d (Å)	I/I1
14.3	15	3.20	5 B
8.41	10	3.13	15
8.05	12	3.04	1
7.62	1	2.98	5
7.18	40	2.88	10 B
6.75	10	2.80	1
6.26	100	2.73	8
5.60	3	2.68	10
5.46	30	2.53	2
5.25	20	2.50	5
5.01	20	2.39	4
4.77	2 B	2.27	4
4.67	10	2.20	1 B
4.28	40	2.18	8
4.18	2	2.14	4
4.04	2	2.11	1
3.93	30	2.09	10
3.85	5	2.05	1
3.69	1 B	2.02	2
3.55	20 B	1.99	1
3.44	25	1.87	2
3.37	2		

52. Morphine Sulphate Pentahydrate

d (Å)	I/I1	d (Å)	I/I1
15.0	70	5.03	45
8.42	35	4.71	20
7.64	50	4.37	90
7.34	1	4.21	1
6.50	60	4.03	40 B
6.20	100	3.87	15 B
5.91	1	3.68	80
5.67	75	3.58	2
5.42	1	3.50	15
5.20	35	3.38	70

52. Morphine Sulphate Pentahydrate (continued)

d (Å)	I/I1	d (Å)	I/I1
3.25	30	2.19	3
3.13	20 B	2.15	15
3.05	10	2.09	8 B
2.94	20	2.00	8 B
2.83	5 B	1.96	5
2.77	1	1.91	1 B
2.65	60	1.84	1 B
2.56	25	1.79	5 B
2.46	5 B	1.75	1
2.30	1	1.70	1
2.27	3	1.67	4
2.23	8	1.59	3

53. Morphine Tartrate Monohydrate

d (Å)	I/I1	d (Å)	I/I1
15.3	15	3.43	2
9.67	20	3.25	30
9.19	20	3.10	3
7.79	40	3.01	10
6.53	40	2.93	2
6.18	10	2.86	1
5.93	20	2.76	2
5.35	100	2.67	1
4.68	50	2.61	15
4.33	5	2.48	1
4.20	25	2.44	1
3.93	1	2.33	1
3.84	3	2.27	5
3.70	3	2.20	3
3.64	3	2.15	4
3.54	3	2.04	4

54. Morphothebaine Hydrochloride

d (Å)	I/I1	d (Å)	I/I1
10.6	100	3.06	2
9.52	25	2.96	10 B
8.87	25	2.83	10 B
7.97	50	2.69	3 B
7.17	30	2.63	2
6.47	15	2.58	2
6.21	3	2.51	10
5.96	5	2.45	3
5.51	5	2.39	3
5.31	60	2.29	2
4.87	20	2.25	1
4.57	10	2.21	2
4.25	5	2.13	5
4.11	4	2.05	1
4.00	8	2.00	2
3.75	100	1.97	1
3.54	100	1.91	2
3.44	15	1.85	15 B
3.37	5	1.78	5
3.24	20 B		

55. Nalorphine Hydrochloride

d (Å)	I/I1	d (Å)	I/I1
10.5	20	3.25	2
7.33	80	3.18	18
6.91	80	3.04	18
6.58	30	3.00	1
6.23	20	2.95	25
5.36	10	2.89	2
5.06	100	2.83	2
4.32	50	2.76	30
4.08	3	2.71	25
4.00	50	2.64	3
3.78	5	2.59	10
3.68	15	2.52	35
3.62	75	2.46	20
3.45	45	2.41	5
3.36	20	2.34	2 B

55. *Nalorphine Hydrochloride (continued)*

d (Å)	I/I₁	d (Å)	I/I₁
2.31	8	1.94	1
2.27	5	1.88	10
2.24	2	1.81	4 B
2.20	3	1.74	2 B
2.12	5	1.68	10
2.07	1 B	1.63	5
2.01	5	1.50	2
1.96	10		

56. *Narceine (free base)*

d (Å)	I/I₁	d (Å)	I/I₁
13.8	100	3.80	30 B
9.67	15	3.56	35
8.75	5	3.44	1
6.86	25	3.33	40
6.17	30	3.07	5
5.61	40	2.97	2
5.24	1 BB	2.86	2
5.08	45	2.75	2 B
4.85	45	2.65	2
4.73	2	2.55	5 B
4.53	5	2.49	1
4.36	15	2.42	4
4.14	50	2.37	4
3.96	45		

57. *Narcotine (free base)*

d (Å)	I/I₁	d (Å)	I/I₁
16.2	25	3.38	1
14.0	3	3.32	20
11.2	20	3.13	5
8.85	10	3.02	2
8.15	1	2.96	10
7.64	75	2.81	2
7.10	30 B	2.77	2
6.48	35	2.67	2
6.22	50	2.62	3
5.91	35	2.53	5
5.70	25	2.49	1
5.50	15	2.44	3
5.33	40	2.38	2
5.06	20	2.34	2
4.93	20	2.28	8
4.79	25	2.22	3
4.53	3 B	2.15	2 B
4.30	25	2.08	1
4.07	20	2.02	2
3.96	15	1.97	2
3.81	50	1.91	1 B
3.75	30	1.86	1 B
3.58	10 B	1.82	3
3.49	100		

58. *Narcotine Hydrochloride (I)*

d (Å)	I/I₁	d (Å)	I/I₁
14.8	30	3.46	15 B
9.22	50	3.30	10 B
7.97	75	3.18	50
7.55	5	3.09	5
7.19	45	3.02	10 B
6.40	100 B	2.92	30 B
5.79	25	2.78	20 B
5.18	50	2.63	3
5.02	5	2.53	5
4.83	60	2.47	3
4.60	2	2.41	3
4.23	80	2.35	3
4.00	50	2.29	5 B
3.84	5	2.17	3 B
3.71	60	2.13	5 B
3.60	40	2.05	2

59. *Narcotine Hydrochloride (II)*

d (Å)	I/I₁	d (Å)	I/I₁
15.9	30	4.24	25 B
12.4	3 B	4.06	50 BB
10.6	75	3.70	40
9.81	15	3.53	40
8.18	100	3.27	30
7.62	50	3.13	35
7.14	3	2.99	5 B
6.76	90	2.86	15 B
6.48	20	2.78	5 B
5.79	15	2.62	20
5.36	15	2.47	5 B
5.02	30	2.17	25
4.54	25 B	2.11	3

60. *Narcotine Hydrochloride (III)*

d (Å)	I/I₁	d (Å)	I/I₁
16.4	25	4.03	50 B
14.8	5	3.83	50 B
11.6	60	3.72	5
10.6	10	3.54	45
9.25	5	3.46	5 B
8.16	65	3.26	40
7.70	8	3.12	30
6.77	100	3.04	40 B
6.53	5 B	2.85	10 B
6.07	5	2.71	8
5.75	3	2.63	5
5.58	20	2.51	10 B
5.20	50	2.41	8
4.66	15 B	2.16	10
4.32	5	2.09	2
4.18	40	1.92	2

61. *Neopine Hydrobromide*

d (Å)	I/I₁	d (Å)	I/I₁
12.2	40	2.42	25
7.56	15	2.35	3
6.64	20	2.32	1
6.04	100	2.25	1
5.64	80	2.21	5
5.22	50	2.18	3
4.88	15	2.14	1
4.70	50	2.10	3
4.20	90	2.02	3 BB
4.02	5 B	1.96	1
3.72	75	1.92	2
3.62	80	1.89	3
3.45	75	1.85	2
3.38	3	1.83	2
3.32	30	1.81	15
3.18	20	1.73	3
3.10	40	1.69	4
2.95	1	1.56	2
2.90	10	1.52	5
2.84	15	1.50	1
2.78	1	1.47	2
2.68	25	1.46	1
2.62	20	1.38	2
2.57	1	1.34	2
2.53	5	1.32	2
2.49	10		

62. *Opianic Acid*

d (Å)	I/I₁	d (Å)	I/I₁
11.1	60	3.91	20
8.25	50	3.77	50
7.39	100	3.48	20
6.80	10	3.39	60 B
5.14	2	3.25	2
4.74	1	3.17	25
4.27	10	3.06	15
4.11	20	3.02	5

62. *Opianic Acid (continued)*

d (Å)	I/I₁	d (Å)	I/I₁
2.88	5	2.33	30
2.84	10	2.27	10
2.77	8	2.22	1
2.69	10	2.12	30
2.64	1	2.07	5
2.57	1	1.86	1

63. *dl-Orphan (free base)*

d (Å)	I/I₁	d (Å)	I/I₁
8.28	40	3.37	1
7.29	1	3.29	1
6.93	20	3.12	3
6.57	20	3.02	5
6.22	60	2.94	4
5.84	100	2.87	10
5.56	25	2.83	20
5.23	20	2.70	25
5.00	10	2.53	15
4.54	15	2.42	12
4.35	8	2.31	5
4.15	75	2.27	5
3.95	25	2.19	20
3.79	10	2.12	8
3.68	25 B	2.02	5
3.54	1	1.99	25
3.44	15		

64. *dl-Orphan Hydrobromide*

d (Å)	I/I₁	d (Å)	I/I₁
14.7	20	3.04	20
10.5	25	2.96	40
7.32	40 B	2.90	40
6.55	40 B	2.77	40
5.97	25	2.61	10 B
5.53	100	2.55	15
5.18	40	2.46	8 B
4.69	60	2.39	1
4.43	20	2.29	8 B
4.08	40	2.22	1
3.94	90	2.14	18
3.80	10	2.10	2
3.60	80	2.05	3 B
3.48	15	2.00	4
3.31	75	1.91	20
3.14	10		

65. *d-, and l-Orphan Tartrate Dihydrate*

d (Å)	I/I₁	d (Å)	I/I₁
9.39	3	3.27	2
8.23	100	3.21	1
7.11	15	3.09	15
6.53	40	2.97	45
6.21	3	2.83	2
6.07	5	2.76	2
5.69	50	2.65	5
5.40	20	2.55	1
4.76	30	2.50	1
4.53	35	2.35	20
4.36	10	2.28	15
4.13	75	2.24	1
3.81	3 B	2.18	2
3.59	5 B	2.06	5
3.48	2	2.03	1
3.40	2	1.95	1
3.34	2	1.92	1

66. *Oxycodone (free base)*

d (Å)	I/I₁	d (Å)	I/I₁
10.5	20	5.21	50
7.70	40	5.03	10
7.14	25	4.77	10
6.80	5	4.51	2
6.45	4	4.18	15
5.88	100	4.03	35

66. *Oxycodone (free base) (continued)*

d (Å)	I/I₁	d (Å)	I/I₁
3.82	10	2.50	1
3.73	1 B	2.43	6 B
3.56	3 B	2.35	2
3.50	30	2.28	1
3.39	1	2.25	8
3.29	25	2.21	2
3.18	5	2.15	5
3.11	8	2.09	2 B
3.05	3	1.99	12
2.98	4	1.95	2
2.92	1	1.91	10
2.77	5 B	1.84	1
2.62	15	1.80	2

67. *Oxycodone Hydrochloride*

d (Å)	I/I₁	d (Å)	I/I₁
11.6	2	3.29	15
10.6	100	3.15	40
9.59	1	3.06	10
8.75	10	2.97	40
8.21	70	2.87	2
7.74	5	2.77	1
7.28	90	2.69	2
6.84	3	2.55	30
6.28	60	2.50	5
6.09	2	2.45	2
5.44	75	2.40	1
5.14	5	2.35	3
4.98	40	2.29	2
4.82	40	2.23	5
4.60	50	2.18	2
4.37	50	2.14	2
4.28	2	2.10	3
4.08	25	2.06	4
3.92	1	2.01	4
3.78	15	1.98	2
3.69	20	1.91	8
3.52	50	1.84	1
3.41	2	1.71	5

68. *Papaverine (free base)*

d (Å)	I/I₁	d (Å)	I/I₁
14.8	10	2.63	3
8.90	12	2.57	20
7.89	3	2.44	2
5.79	100	2.39	10
5.21	25	2.33	8 B
4.93	30	2.21	8
4.77	30	2.18	3
4.61	40	2.13	2
4.48	20	2.10	8
4.38	2	2.02	3 BB
4.26	25	1.95	20 B
3.87	85	1.88	4 B
3.73	90	1.84	5
3.65	5	1.82	1
3.57	5	1.81	1
3.51	15	1.79	1
3.35	2	1.74	4
3.28	40	1.71	6
3.13	25 B	1.66	2 B
3.01	15	1.61	4
2.90	1	1.57	1
2.78	30 B	1.54	2

69. *Papaverine Hydrochloride*

d (Å)	I/I₁	d (Å)	I/I₁
10.1	20	4.56	100
7.87	20	4.44	70
6.85	40	4.32	3
6.59	5	4.20	3
5.93	15	4.08	25
5.35	40	3.79	20
5.12	75	3.68	60

69. *Papaverine Hydrochloride (continued)*

d (Å)	I/I₁	d (Å)	I/I₁
3.57	75	2.55	20
3.42	75	2.48	2
3.35	25	2.40	2
3.14	1	2.34	1
3.04	1	2.23	5 B
2.97	10	2.09	5 B
2.89	5	1.96	3
2.85	2	1.88	4
2.75	20	1.71	1
2.67	5		

70. *Pethidine (free base)*

d (Å)	I/I₁	d (Å)	I/I₁
9.49	100	3.23	8
7.68	1	3.14	10
7.27	1	3.01	2
5.99	10	2.90	20
5.72	1	2.82	5
5.46	80	2.60	25
5.21	8	2.49	1
4.93	1	2.35	1
4.79	60	2.30	8
4.50	10 B	2.24	1
4.36	12 B	2.20	1
3.99	30	2.15	10
3.87	3	2.11	2
3.78	50	2.04	3
3.62	12	1.99	12
3.56	5	1.93	1
3.47	10	1.89	5
3.36	10		

71. *Pethidine Hydrochloride*

d (Å)	I/I₁	d (Å)	I/I₁
8.04	100	3.06	25
7.72	5	2.99	4
6.65	20	2.94	1
5.73	60	2.86	25
5.24	40	2.80	2
5.14	50	2.74	10
4.75	3	2.68	4
4.67	75	2.59	10
4.50	5	2.43	3
4.31	5	2.33	1
4.17	3	2.25	4
4.08	50	2.22	5
3.96	15	2.17	2 B
3.73	3 B	2.05	3
3.61	90	1.98	2 B
3.55	5	1.94	5
3.41	5	1.90	1
3.34	3	1.84	1
3.22	2	1.80	2
3.14	2		

72. *Phenadoxone (free base)*

d (Å)	I/I₁	d (Å)	I/I₁
8.79	25	3.48	2
8.07	35	3.38	10
7.62	45	3.25	3
6.43	10	2.95	2
6.20	100	2.78	10
5.97	1	2.73	5
5.69	1	2.64	15
5.40	1	2.59	2
5.18	40	2.44	10
4.89	25	2.38	7
4.65	3	2.30	15
4.50	90	2.25	5
4.34	15	2.11	3
4.09	35 B	2.08	3
3.88	40	2.02	15 B
3.76	35	1.92	10
3.64	2	1.87	1
3.58	40	1.83	3

73. *Phenadoxone Hydrochloride*

d (Å)	I/I₁	d (Å)	I/I₁
12.8	30	2.94	8
7.59	25	2.87	50
7.39	40	2.79	3
6.39	100	2.66	2
5.72	60	2.56	20
5.20	100	2.48	10
4.67	25 B	2.39	1
4.40	50 B	2.31	20
4.16	40	2.18	5
3.97	20	2.15	5
3.84	90	2.10	1
3.62	50	2.04	3
3.49	10 B	1.98	1 B
3.11	20 B	1.92	1 B
3.03	25 B	1.80	3 B

74. *Pipidone Hydrochloride*

d (Å)	I/I₁	d (Å)	I/I₁
10.8	40	3.01	20
9.88	45	2.92	25
8.41	5	2.82	1
7.62	2	2.76	2
7.08	100	2.69	2
5.97	4 B	2.60	5
5.60	20	2.54	1
5.40	25	2.48	3
5.10	10	2.37	4
4.94	80	2.32	5
4.33	20	2.26	1
4.19	50	2.22	2
3.92	2	2.18	3
3.72	25	2.12	1
3.54	30	2.00	3
3.33	20	1.96	5
3.14	8	1.89	1

75. *dl-α-Prodine Hydrochloride*

d (Å)	I/I₁	d (Å)	I/I₁
15.1	50	3.25	1
7.50	5	3.09	20 B
7.14	100	3.00	10
6.87	1	2.87	3
6.69	70	2.83	3
5.96	80	2.67	5
5.52	10	2.59	10
5.16	60	2.54	2
5.01	10	2.49	2 B
4.74	30	2.39	3 B
4.56	30	2.32	1
4.39	5	2.23	8
4.27	25	2.16	2
4.06	20	2.12	5
3.88	20	2.04	3
3.78	30	1.98	2 B
3.58	60	1.89	1
3.45	30	1.79	1
3.34	5	1.67	2

76. *dl-β-Prodine Hydrochloride*

d (Å)	I/I₁	d (Å)	I/I₁
11.2	20	3.52	25
8.13	100	3.31	20
6.08	25	3.24	3
5.87	70	3.18	3
5.39	20	3.09	3 B
5.24	15	2.95	25
5.10	70	2.83	20
4.63	5	2.79	1 B
4.41	15	2.71	1
4.23	40	2.66	1
4.08	40	2.61	3
3.82	40 B	2.52	2 B
3.69	40 B	2.46	1 B

76. *dl-β-Prodine Hydrochloride (continued)*

d (Å)	I/I₁	d (Å)	I/I₁
2.40	5	2.03	3 B
2.35	2	1.97	5
2.31	5	1.94	5
2.20	15 B	1.91	1 B
2.13	1	1.87	2 B

77. *Propylketobemidone (free base)*

d (Å)	I/I₁	d (Å)	I/I₁
10.6	100	2.80	10
9.05	10	2.62	20
6.73	15	2.50	5
6.09	1	2.43	2
5.77	50	2.35	2
5.35	1	2.30	10
5.02	90	2.24	20
4.54	10	2.15	1
4.37	1	2.11	20
4.19	30	2.07	1
4.01	20	2.00	25
3.91	50	1.96	1
3.78	1	1.93	1
3.65	30	1.90	5
3.54	10	1.87	2
3.30	30	1.81	3
3.02	10	1.74	5
2.94	30 B		

78. *Protopine (free base)*

d (Å)	I/I₁	d (Å)	I/I₁
10.7	20	2.68	10
8.74	35	2.63	25
6.77	25	2.59	1 B
6.57	5	2.53	3 B
6.31	30	2.43	5
5.96	90	2.40	3
5.51	5	2.36	3
5.30	30 B	2.25	20 B
4.97	35	2.20	2
4.47	100	2.18	20
4.36	80	2.14	1
4.16	25	2.09	2 B
4.01	80	2.01	2
3.87	20	1.96	5
3.65	60	1.89	5 B
3.53	2	1.81	3
3.46	45	1.79	10
3.34	8	1.77	15
3.28	10	1.73	2
3.14	25	1.70	3
3.09	20	1.65	2 B
3.00	5	1.62	1
2.95	10	1.58	2
2.91	5	1.56	2
2.86	5	1.44	2 B
2.77	3 B		

79. *Pseudomorphine Trihydrate (free base)*

d (Å)	I/I₁	d (Å)	I/I₁
9.23	30	3.56	60
8.76	75	3.37	10
8.15	25	3.09	5
7.25	15	3.02	4
6.54	100	2.93	2
6.11	25	2.80	2
5.82	10	2.73	2
5.52	20	2.58	1
4.86	5	2.40	5
4.60	5	2.26	3
4.44	75	2.14	1
4.14	15	2.10	1
4.02	15	2.04	4
3.90	3	1.99	2
3.73	15	1.94	1
3.64	2		

80. *Sinomenine Hydrochloride Dihydrate*

d (Å)	I/I₁	d (Å)	I/I₁
11.5	40	3.07	40
9.62	75	2.89	40
7.12	5	2.72	25
6.75	75	2.64	12
6.45	40	2.58	2
6.11	100	2.53	2
5.75	25	2.47	15
5.36	15	2.40	2
5.09	1	2.31	5
4.91	75	2.26	15
4.79	1	2.19	40
4.56	25	2.15	2
4.28	60	2.09	2
4.01	60	2.04	1
3.90	50	1.99	8
3.71	20	1.96	1
3.58	4	1.93	1
3.51	25	1.84	5
3.39	50	1.70	2
3.30	50	1.60	1
3.21	25	1.56	1

81. *Thebaine (free base)*

d (Å)	I/I₁	d (Å)	I/I₁
7.76	100	3.31	12
7.43	30	3.17	15
6.85	30	3.07	1
6.35	40	2.95	25
5.65	35	2.73	1
5.11	90	2.50	2
4.90	10	2.37	10
4.66	10	2.29	4
4.28	5	2.19	3 B
4.18	20	2.04	2
4.06	35	1.99	2
3.89	3	1.95	1
3.73	90	1.88	2 B
3.43	10		

82. *Thebaine Hydrochloride*

d (Å)	I/I₁	d (Å)	I/I₁
7.44	100	2.56	2
6.99	30	2.51	25
6.75	20	2.44	5 B
5.97	5	2.39	10
5.62	10	2.34	10
5.32	35 B	2.27	30
4.88	50	2.21	5
4.71	45	2.16	10
4.29	45	2.08	10
4.12	40	2.00	2
3.79	25	1.92	20
3.63	40	1.87	2
3.47	60	1.85	2
3.37	10	1.82	25
3.26	20 B	1.80	3
3.16	30	1.76	3
3.00	20	1.73	3
2.94	20	1.71	15
2.83	35	1.66	1 B
2.78	5	1.62	1 B
2.71	3	1.58	3 B
2.66	10	1.54	1
2.61	10	1.51	2

83. *Thebenine Hydrochloride Monohydrate*

d (Å)	I/I₁	d (Å)	I/I₁
10.7	60	3.36	5
6.04	20	3.29	2
5.52	40	3.02	15
4.45	100	2.85	2
4.25	50	2.75	8
4.10	3	2.53	5
3.99	10	2.46	2
3.47	75		

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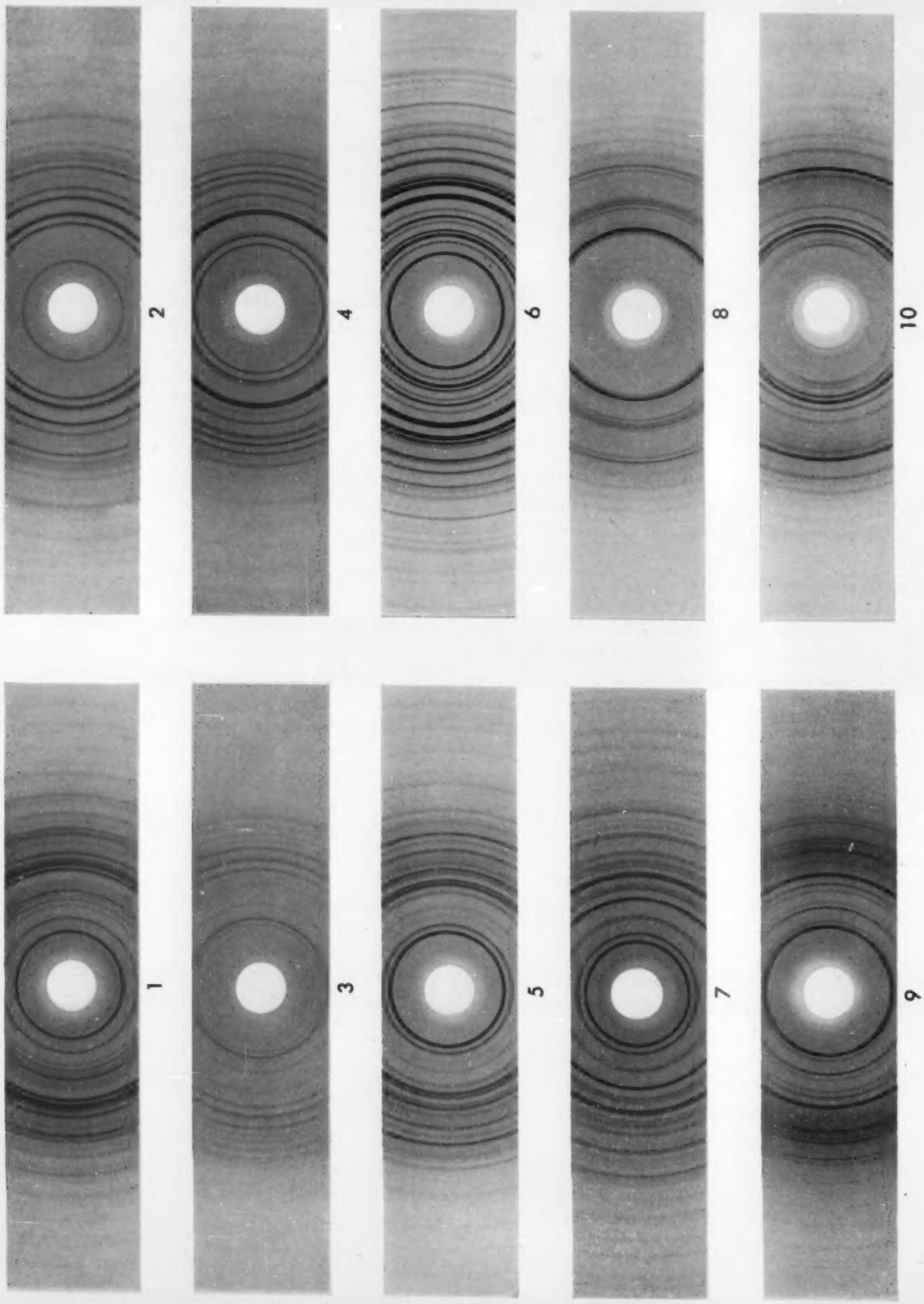
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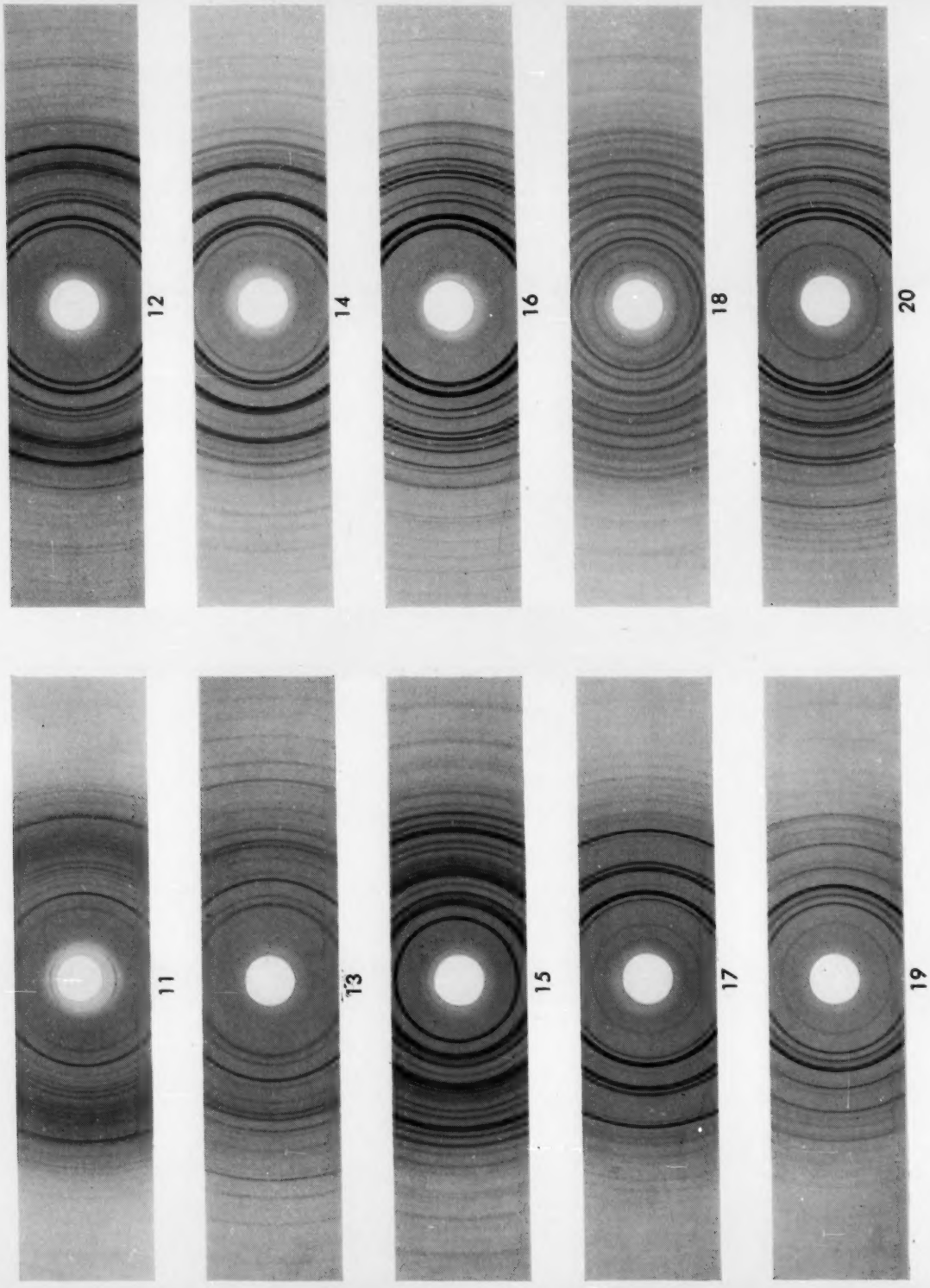
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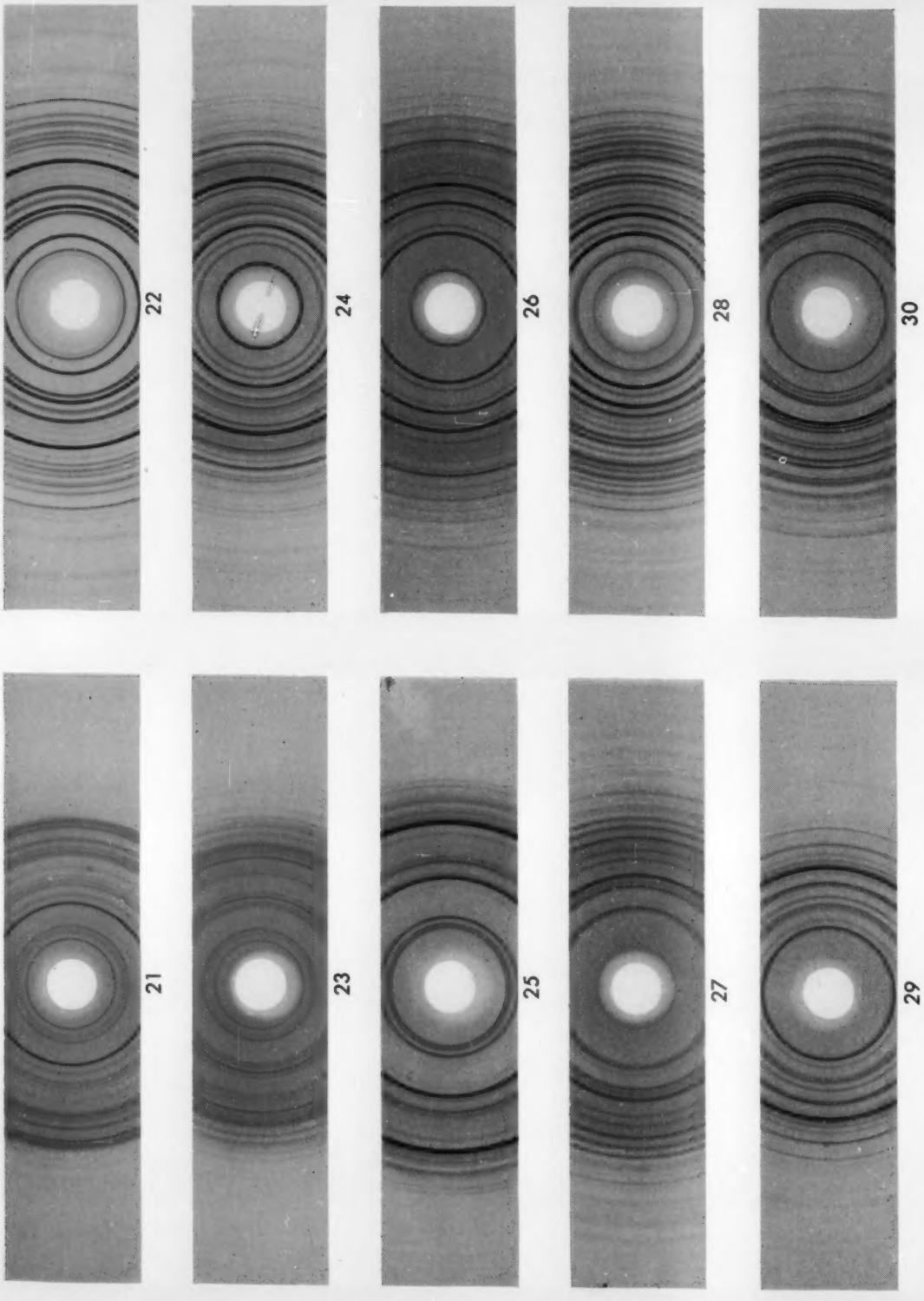
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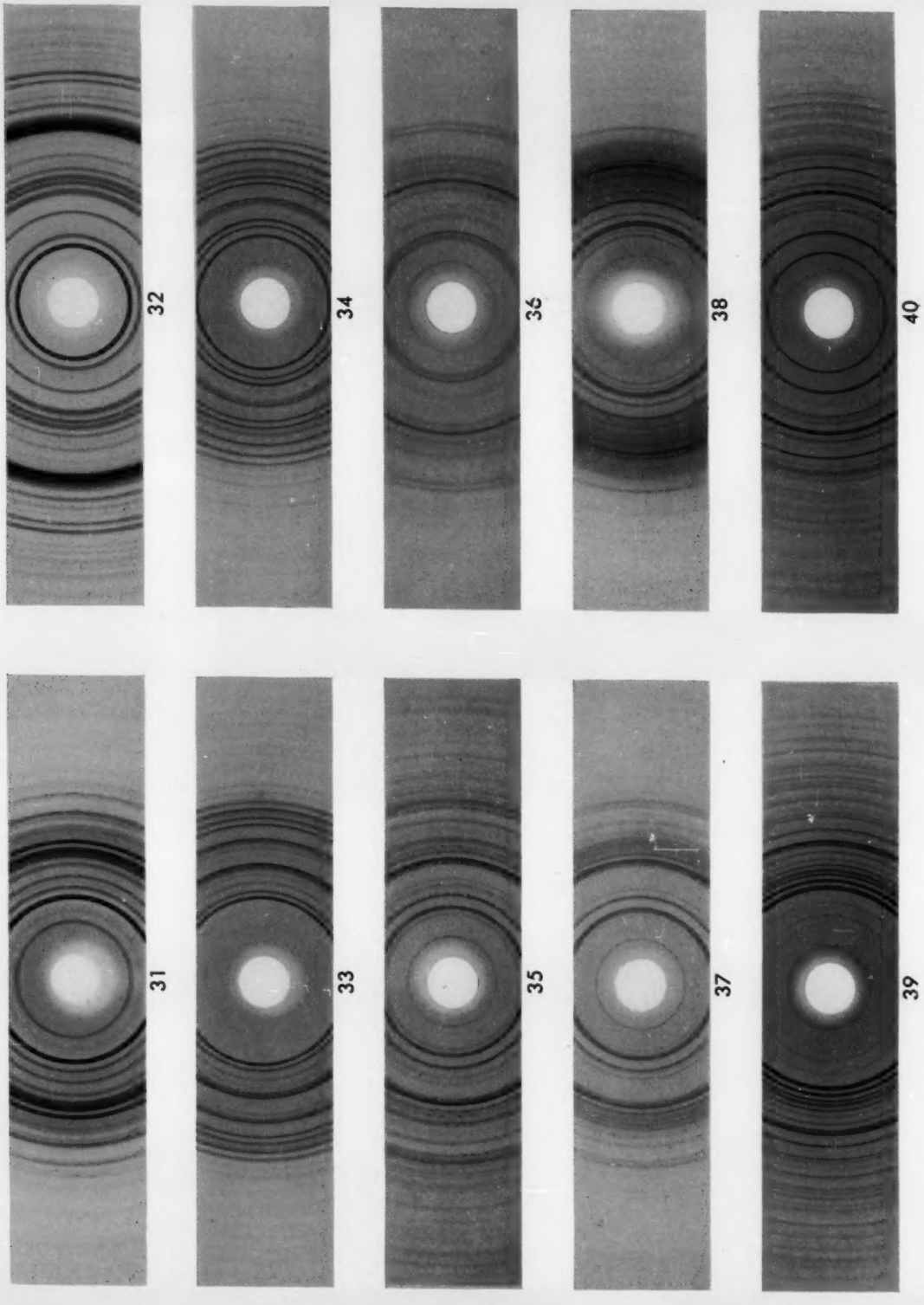
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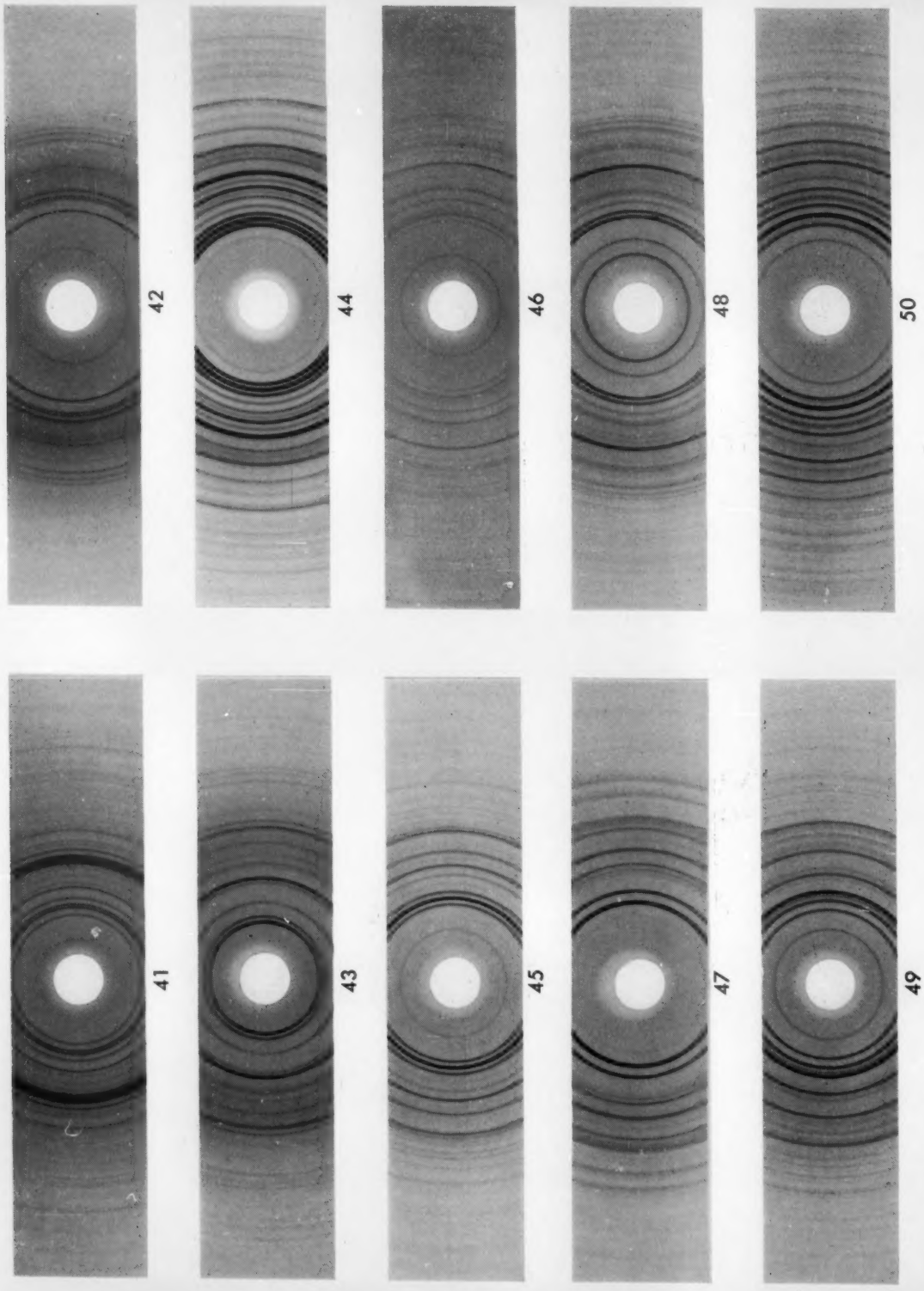
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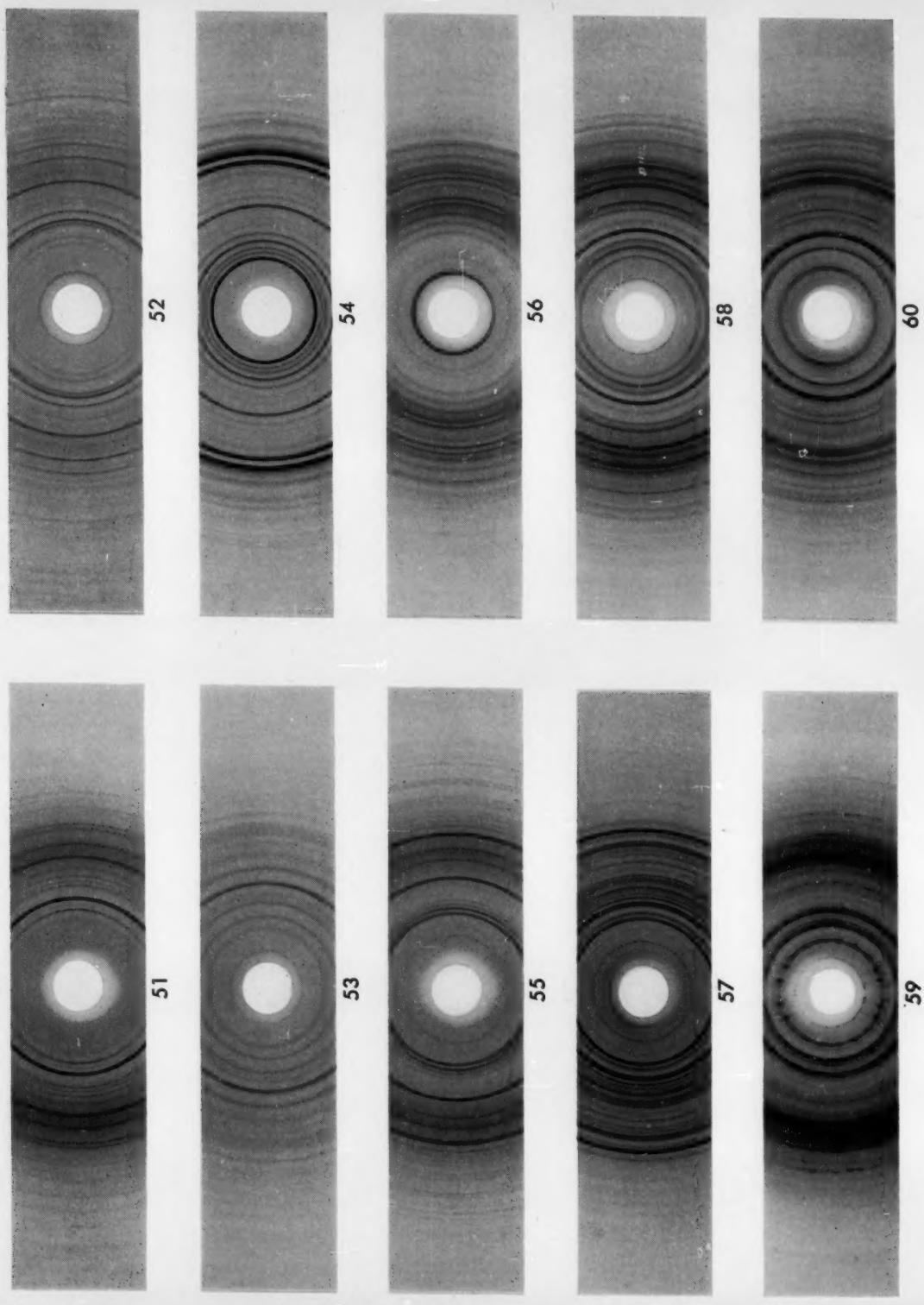
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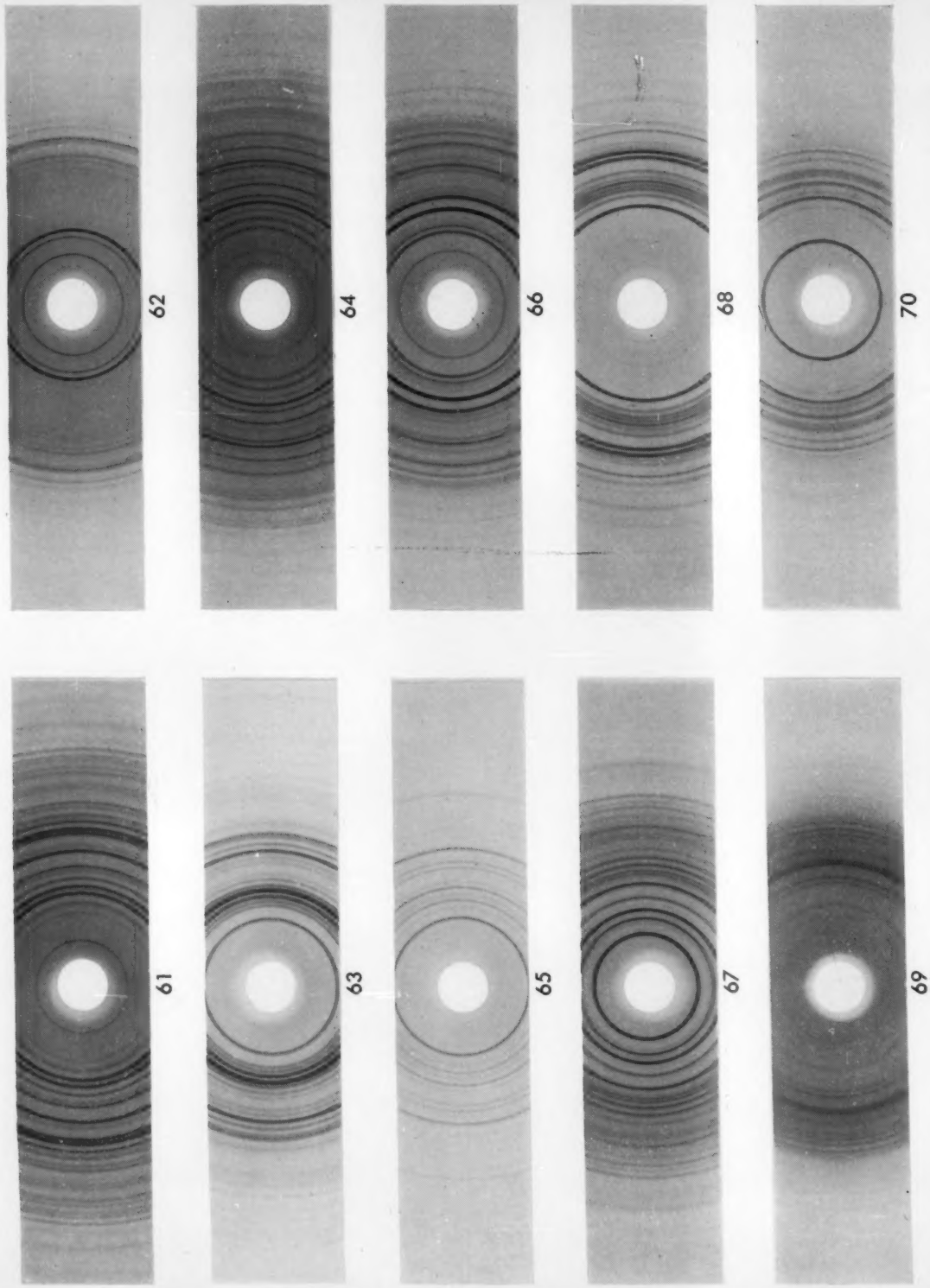
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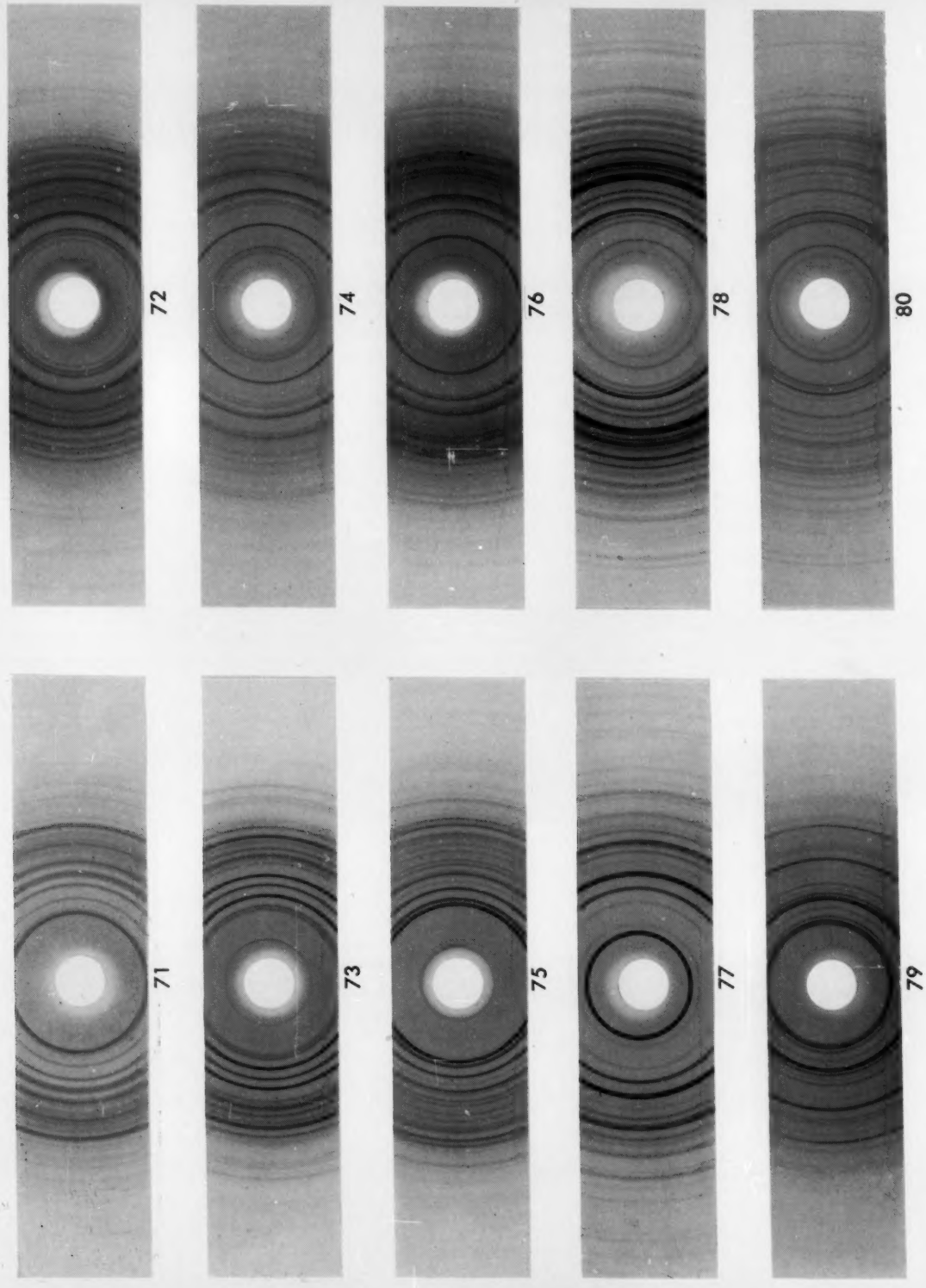
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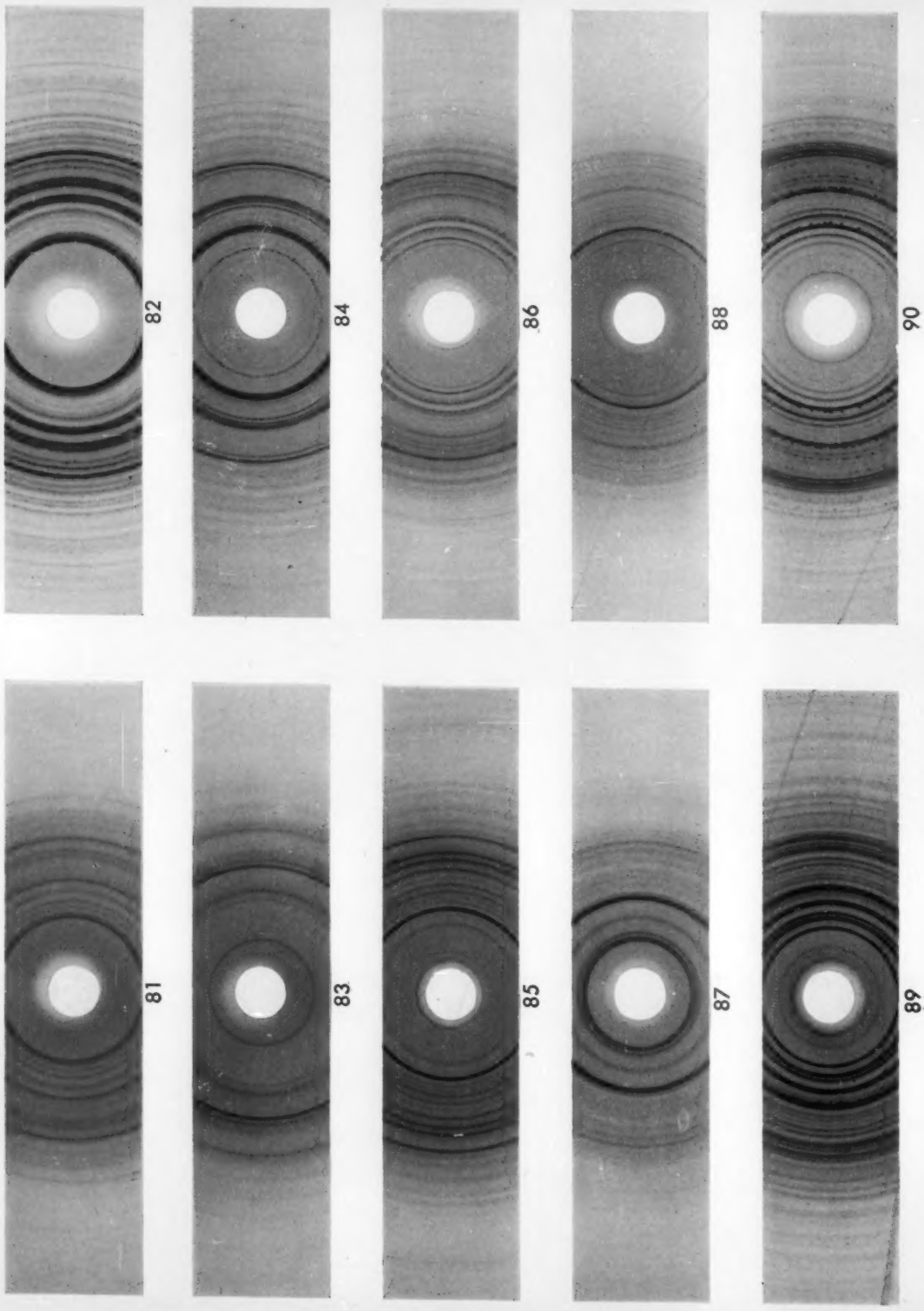
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OFFICIAL

Evolution in 1952 of National Legislations on Narcotics

The Secretary-General regularly issues an Annual Summary of Laws and Regulations relating to the control of narcotic drugs. The last Summary (document E/NL.1952/Summary—November 1953) is based on texts of laws communicated by governments between 31 May 1952 and 1 August 1953.[1]

Much of the material is concerned with routine steps taken by governments to implement the provisions of the international conventions on narcotic drugs. The legislations show in general the same trends as could be observed in earlier years. Such factors as new synthetic developments and new international narcotic treaties continue to guide the course of governmental action and tend to create an increasing similarity of national legislation in this field. The points which seem to present a special interest are:

(*a*) The consolidation of legislation on narcotic drugs in eight countries and territories has resulted in enlarging the lists of controlled drugs and in tightening the machinery of control.

(*b*) The extension of national control to synthetic narcotic drugs, which have been brought under international control through the application of the 1948 Protocol, has continued to engage the attention of the legislative and executive branches of the governments in a number of States, including some which have not yet become parties to the 1948 Protocol.

While the summaries for 1949, 1950 and 1951 gave, respectively, 22, 32 and 26 countries as having subjected one or more of the synthetic narcotic drugs to national control, the present *Summary* gives 35 countries.

Of the 114 States and territories to which the 1948 Protocol applies, 10 have subjected to national control all the synthetic drugs covered by the international treaties and 80 have subjected to control one or more of these drugs, pethidine and methadone being controlled in the largest number of countries.

(*c*) Several laws show a medical approach to the problem of drug addiction. Drug addicts or habitual "drug users" are made subject to compulsory medical treatment. Procedure for commitment of the addicts to hospitals or institutions authorized for the treatment of "disease or inebriety of drug addiction" is outlined in detail in two of these laws.

(*d*) India and Pakistan have extended total prohibition of opium smoking to certain parts, while subjecting opium smoking to control in others. Opium smoking assemblies are prohibited in India, in Jammu and Kashmir and in Pakistan. In Malaya, opium smoking and the keeping and frequenting of opium dens are absolutely prohibited.

(*e*) A number of laws provide measures for preventing the escape of drugs into illicit channels on both the wholesale and retail levels by application of: (1) systems of licensing the transferring, storing and marketing of narcotics drugs, and (2) systems of reporting and recording, together with verification of medical prescriptions.

As far as new accessions to the narcotic treaties are concerned the following should be noted:

1948 Protocol

Instruments of acceptance were deposited with the Secretary-General on behalf of:

Greece ..... (29 July 1952),
Ireland ..... (11 August 1952),
Pakistan ..... (27 August 1952),
Luxembourg ..... (17 October 1952),
Switzerland ..... (18 March 1953).

1953 Protocol[2]

First, the Protocol has been signed by:

Cambodia	29 December	1953
Canada	23 December	1953
Chile	9 July	1953
China	18 September	1953
Costa Rica	16 October	1953
Denmark	23 June	1953
Dominican Republic	23 June	1953
Egypt	23 June	1953
Ecuador	23 June	1953
Federal Republic of Germany	23 June	1953
France	23 June	1953
Greece	23 June	1953
India	23 June	1953
Iran	15 December	1953
Iraq	29 December	1953
Israel	30 December	1953
Italy	23 June	1953
Japan	23 June	1953
Lebanon	11 November	1953
Liechtenstein	23 June	1953
Monaco	26 June	1953
Netherlands	30 December	1953

[1] For laws and regulations relating to the control of Narcotic Drugs in 1951, see Volume V, No. 1, of the *Bulletin*.

[2] For the 1953 Protocol the list of signatures and ratifications, which is not complete in the Summary of Laws, has been brought up to date by the editors.

New Zealand	28 December	1953
Pakistan	3 December	1953
Panama	28 December	1953
Philippines	23 June	1953
Republic of Korea	23 June	1953
Spain	22 October	1953
Switzerland	23 June	1953
Turkey	28 December	1953
Union of South Africa	29 December	1953
United Kingdom and Northern Ireland	23 June	1953
United States of America	23 June	1953
Venezuela	30 December	1953
Viet-Nam	23 June	1953
Yugoslavia	24 June	1953

Second, the following countries have ratified the Protocol:

Canada	7 May	1954
China	25 May	1954
Denmark	20 July	1954
Egypt	8 March	1954
France	21 April	1954
India	30 April	1954
Japan	21 July	1954
Panama	13 April	1954

Two laws appear to be of special interest to the readers of the *Bulletin* and, therefore, will be presented here. The first is the Statute of the Drug Addict in the District of Columbia of the United States of America:

United States of America District of Columbia: The term "drug user" is defined as meaning a person who habitually uses any habit-forming narcotic drugs so as to endanger the public morals, health, safety or welfare, or who is so far addicted to the use of such habit-forming narcotic drugs as to have lost the power of self-control with reference to his addiction. Whenever[3] it appears to the United States Attorney for the District of Columbia that a person within the District is a drug user, he may file with the clerk of the United States District Court for the District of Columbia a statement in writing setting forth the facts tending to show that such a person is a drug user. Upon the filing of such a statement, the court is required to order that the patient[4] appear before it for an examination by physicians and for a hearing if required. The copy of the statement and order of the court shall be served personally upon the patient by the United States Marshal. A patient shall have the right to assistance of counsel at every stage of the judicial proceeding. Before the court appoints physicians, it is required to advise the patient of his right to counsel and to assign counsel to represent him if he is unable to obtain counsel.

When a statement has been filed, the court is required to appoint two qualified physicians, one of whom shall be a psychiatrist, to examine the patient. For the purpose of the examination, the court may order the patient committed for such reasonable period as the court may determine to a suitable hospital or other facility to be designated by the court. Each physician shall, within such periods as the court may direct, file a written report of the examination, which shall include a statement of his conclusion as to whether the patient is a drug user.

The counsel for the patient may inspect the reports of the examination. No such report and no evidence resulting from the personal examination of the patient or evidence offered by the patient shall be admissible against him in any judicial proceeding, except proceedings under the District of Columbia addiction legislation.

If, in a report filed, either of the examining physicians states that the patient is a drug user, or that he is unable to reach any conclusion by reason of the refusal of the patient to submit to thorough examination, the court is required to conduct a hearing. If, on the basis of the reports filed, the court is not required to conduct a hearing, it shall enter an order dismissing the proceeding. If a hearing is deemed necessary, then such notice of hearing is to be served personally upon the patient to afford him the opportunity to prepare for the hearing.

Upon the evidence introduced at a hearing held for that purpose, the court is required to determine whether the patient is a drug user. The hearing must be conducted without a jury unless, before the hearing and within fifteen days after that date on which the second report of the physicians is filed, a jury is demanded by the patient or the United States Attorney. The patient may, after appointment or employment of counsel, waive a hearing and be committed directly to a hospital designated by the Commissioners of the District of Columbia, or their designated agent. The rules of evidence applicable in judicial proceedings in the court are applicable to hearings, including the right of the patient to present evidence in his own behalf and to subpoena and cross-examine witnesses. If the court finds the patient to be a drug user, it may commit him to a hospital designated by the patient or the Commissioners of the District of Columbia, or their designated agent, and approved by the court, to be confined there for rehabilitation until released. The head of the hospital shall submit reports, within such periods as the court may direct, but no longer than six months after the commitment and for successive intervals of time thereafter, and state reasons why the patient has not been released.

When the head of the hospital to which the patient is committed finds that the patient appears to be no longer in need of rehabilitation, or has received maximum benefits, they shall give notice to the judge of the committing court. The patient is then to be delivered to the court for such further action as the court may deem necessary and proper. Upon petition of the patient after confinement for one year, the court is required to inquire into the refusal or failure of the head of the hospital to release him. If the court finds that the patient is no longer in need of care, treatment, guidance or

[3] The United States Attorney may not file a statement with respect to a person who is charged with a criminal offence, whether by indictment or by information, or who is under sentence for a criminal offence, whether he is serving the sentence, or is on probation or parole, or has been released on bond pending appeal.

[4] The term "patient" means a person with respect to whom there has been filed with the clerk of the United States District Court for the District of Columbia a statement, as set out above.

rehabilitation, or has received maximum benefits, it shall order the patient released.

For the two years after his release, the patient shall report to the Commissioners of the District of Columbia, or their designated agent, at such times and places as those officers, or officer, require, but not more frequently than once each month, for a physical examination to determine whether the patient has again become a drug user. If the Commissioners of the District of Columbia, or their designated agent, determine that the person examined is a drug user, they are required to notify the United States Attorney for the District of Columbia who may then file a statement with respect to the person examined.

Patients falling within the scope and definition of District of Columbia addiction legislation shall not be deemed criminals; commitment of any such patient shall not be deemed a conviction [1025].

The second is the *Decree of 23 April 1953 prohibiting the Cultivation of Indian Hemp and the Use of Takruri*[5] in Tunisia, transmitted by the French Government.

The cultivation, harvesting, preparation, processing, possession, offer, distribution, brokerage, purchase, sale, carriage, importing or exporting of Indian hemp or takruri or preparations containing the active constituents thereof shall be prohibited.

The consumption of Indian hemp or takruri or preparations containing them shall be prohibited.

For the time being, however, internal trade in and use of Indian hemp and its products shall be permitted for medical or veterinary purposes within the limits of the provisions of the aforementioned Decree of 1 August 1939 (14 Jumada II 1358) concerning the importing, purchase, sale, possession and use of toxic substances, until the stocks held by dispensing chemists, hospital dispensaries and establishments authorized to trade therein have been exhausted, and at the latest until 1 January 1955.

Any pharmacists stocking Indian hemp and its products for medical use who destroy their stocks shall record the fact in their narcotics' registers, stating the date of destruction and the quantities destroyed.

The prohibition and regulations on Indian hemp and takruri or kif in the aforementioned Decrees of 3 October 1884 (14 Dhulhijja 1301) and 1 August 1939 (14 Jumada II 1358) and in this Decree shall apply without distinction to all types of hemp excepting only hemp for textiles, the production of which shall be subject to the provisions of article 5.

The Director of Finance, upon the proposal of the Minister of Trade, may authorize the cultivation of hemp for textiles.

Authorized planters shall be liable to visits and inspections by the agents and inspectors of the financial administration in the manner set forth in article 10 of the Decree of 5 April 1922 (7 Shaaban 1340) on the cultivation of tobacco.

Hemp for textiles may be transported only with a permit issued by the Director of Finance, who shall prescribe by decree methods of destroying all those parts of the plants which may be used in the preparation of takruri, kif or any other product which may be smoked or consumed.

Any hemp grown for textiles without permission shall be destroyed by the cultivator or at his expense by the authority discovering the offence.

The offender shall in addition be sentenced to a fine computed at the rate of one thousand francs (1,000 francs) per 100 plants, any fraction of 100 counted as 100 plants, up to a total not exceeding 50,000 francs, but in no case less than 5,000 francs.

If the illicit hemp was grown on enclosed ground, the fine shall be doubled.

The number of plants shall be obtained by measuring the area under illicit cultivation by ordinary surveying methods, and reckoning ten plants to each square metre.

The possession of hemp grown without authorization shall be subject to a fine of 500 francs per kilogram or fraction of a kilogram for hemp on the stalk and of 2,000 francs for hemp flowers which may be used in the preparation of takruri, kif or other products containing the active constituents thereof, the total fine in no case to be less than 5,000 francs nor more than 70,000 francs.

The products seized shall be destroyed at the expense of the offender.

The internal carriage of hemp, whether in the form of plants, stalks or flowers, without a permit from the Director of Finance, shall render the offender liable to the same fine as that for illegal possession and, in addition, to the seizure and confiscation of the means of transport.

The same fine shall be imposed upon the person convicted of supplying the hemp.

Any person engaging in the house-to-house sale or peddling of hemp, takruri or kif or of preparations containing the active constituents thereof shall, without prejudice to the penalties provided for in chapter 4 of the Decree of 1 August 1939 (14 Jumada II 1358), be liable to the confiscation of the means of transport and in addition:

(1) if the offence is committed by less than three persons, to imprisonment for not less than three days and not more than one month;

(2) if the offence is committed by a group of three or more persons, to imprisonment for not less than one month and not more than one year;

(3) if the offence is committed by a group of three or more persons carrying weapons, to imprisonment for not less than three months and not more than three years.

[5] Published in *Journal Officiel Tunisien* No. 34, of 28 April 1953.

If the offence is repeated, the fines set forth in this Decree shall be doubled. Any fresh infringement committed within the five Gregorian years following a sentence which has been confirmed shall be deemed a repetition of the offence.

For the time being and until the stocks held by the Administration are exhausted, or until 31 December 1954 at latest, the provisions of the Decree of 11 April 1927 (9 Shawwal 1345) on the manufacture, distribution, possession and sale of takruri shall remain in force.

The provisions of article 18 of the Decree of 11 April 1927 (9 Shawwal 1345) shall likewise remain in force for the time being and until stocks in possession of the monopolies service are exhausted, or until 31 December 1954 at latest.

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Synthetic Drugs—I and II

Introduction

The following bibliography has been prepared by the Secretariat and includes the first two parts of a general bibliography on synthetic drugs. The other parts will deal with methadone—III, morphinan and morphine synthesis —IV, dithienylbutenylamines and miscellaneous synthetics—V. The three last parts will be given in Volume VI, No. 3-4.

The *Bulletin* has already published a Bibliography on Synthetic Drugs (Volume III, No. 2) but since 1950 a great quantity of new works have been published justifying this second bibliography on the same subject. This bibliography has no claim to be complete and information regarding books or articles not included in it would be gratefully received by the Division of Narcotic Drugs, United Nations Secretariat. Due to the nature of the sources available to the Secretariat, several titles are given in translation only. They are preceded by an asterisk.

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ERRATA

Bulletin on Narcotics, Vol. V, No. 4, October to December, 1953 — Part IA

Page	
20	Title IIA "The X-ray Diffraction Method on Powder" should read, "The "X-ray Diffraction Powder Method".
20	Title IIB "X-ray Diffraction Data on Powder for Eighty-three Narcotics", should read, "X-ray Diffraction Powder Data for Eighty-three Narcotics".
23	*dl*-β- methadols should read "*dl*-β-methadols". β- prodines should read "β-prodines".
23	derivitization should be derivatization.
31	Reference 36 should be "Biochemische" not "Brichemische".

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Page	
10	Column 1, 150-160 in table of observed melting points for morphine, ethyl, HCl, dihydrate should read 150-160 d.
10	Column 2, *dl*-α-(trans) should read, *dl*-β-(trans).
10	Column 1, insert "d". after 152°-155°C. in last line.
12	Column 1 of Table I, acedicon® should read Acedicon®.
12	Column 10, Table I, delete 7, below 7 & 13 opposite codeinone dihy-.
14	Column 1, Table I (cont'd-3) delete the asterisk in front of *l*-morphinan, etc., in compound 9 on this page.
15	Column 1, Table I (cont'd-4) delete the asterisk from in front of morphinone, etc., compound 3 on this page.
15	(hydromorphone hydrochloride) should read (metopon hydrochloride), after compound 4, on this page.
15	delete "P" from in front of P,β-phenethylamine etc., compound 14.
15	Column 1, table I (cont'd. 4) (Alphaprodine) should read (alphaprodine) compound 16.
17	(pyrahexyl®) should read (Pyrahexyl®).
17	Column 2 of Table II, insert Dihydrohydroxycodeinone (see oxycodone) Dihydrohydroxycodeinone hydrochloride (see oxycodone hydrochloride).
18	Delete "see" from (see codeinone, dihydro).
19	Reference 8, should read Oestreicher, P. M., Farmilo, C. G. and Levi, L. etc.
19	Reference 27—Rindeknecht, should read, Rinderknecht.
19	Reference 27, delete colon (:) and insert comma after L and before and.
19	Reference 30, add page 146.

Page	
iii	Table of Contents, Technical, line 5, should read: "Part IIA, The X-ray Diffraction Powder Method".
20	Title, should read "The X-ray Diffraction Powder Method".
20	Column 2, line 45, should read "to the K shell'.
20	Column 2, line 47, should read "from the L to the K shell".
23	Column 2, lines 11, 12, $\overrightarrow{\text{II}}$, $\overrightarrow{\text{II}}$ should be $\leqq$, $\geqq$.
23	Fig. 3, caption, should read "X-ray diffraction cones".
25	Column 2, line 10, should read "d vs. θ (16)".
26	Column 1, line 15, should read "to an X-ray beam".
27	Column 1, line 24, should read "of the order of 10^{-3} to".
27	Column 1, line 45, "stereoscopic".
27	Column 1, line 49, should read "dipping the end".
27	Column 1, line 53, "specimens".
28	Figure 5, should be "Figure 6".
28	MoKα, (Zn filter) should read "(Zr filter)".
29	Column 1, line 32, should read "figure 6".
29	Column 1, line 38, should read "figure 5".
29	Column 1, line 42, should read "figure 6".
29	Column 2, lines 2, 3, should read "figure 6".
29	Figure 6, should be "Figure 5".
30	Column 1, line 10, should read "Samples as small".

Throughout the paper, capital Θ should be small θ.

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